Identified Wildlife Management Strategy

Accounts and Measures for Managing Identified Wildlife

Southern Interior Forest Region

Version 2004

British Columbia
Ministry of Water, Land and Air Protection

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Preface

The Identified Wildlife Management Strategy is an initiative of the Ministry of Water, Land and Air Protection, in partnership with the Ministry of Forests and carried out in consultation with other resource ministries, stakeholders and the public. Statutory authority is provided for the Ministry of Water, Land and Air Protection to carry out this strategy under provisions of the *Forest Practices Code of British Columbia Act* and regulations, and under the new *Forest and Range Practices Act* and regulations, to be implemented in 2004.

Two companion documents address the management of Identified Wildlife, and together, comprise the Identified Wildlife Management Strategy (IWMS). The first document, *Procedures for Managing Identified Wildlife*, describes the procedures for establishing, modifying and rescinding a wildlife habitat area (WHA), and for implementing strategic and landscape level planning recommendations. This document provides direction to government planners, foresters and wildlife managers.

The second document, *Accounts and Measures for Managing Identified Wildlife*, summarizes the status, life history, distribution and habitats of Identified Wildlife, and outlines specific guidelines for management of their habitats. For ease of use, the *Accounts and Measures* report is available as three separate documents, one for each of the Coast, Northern Interior, and Southern Interior regions. Only species occurring within that region are included along with all introductory and appendix materials. As a result, note that some species will occur in more than one report (e.g., Grizzly Bear occurs in all three reports).

These documents are a resource for government planners, foresters and wildlife managers, and for those persons interested in the life histories of Identified Wildlife. They provide the necessary information, procedures, practices and guidelines to help achieve effective management and conservation of Identified Wildlife under the *Forest and Range Practices Act*.

Acknowledgements

A project of this magnitude was made possible only through the long-standing executive support of Ralph Archibald, Gordon Macatee, Bruce Morgan, Larry Pedersen, Derek Thompson, Gary Townsend, Jim Walker, and Nancy Wilkin. Rod Davis and Brian Nyberg were also strong supporters, and provided prudent facilitation and direction.

The cooperation and advice of two important committees made this project go smoothly. The IWMS Technical Government Working Group and Technical Advisory Committee were integral in the development of the accounts, and contributed much time and effort to reviewing this document.

The IWMS Technical Government Working Group, an interagency committee, provided overall project direction as well as strategic and technical review of accounts. Representatives included Wayne Erickson (Ministry of Forests [MOF]); Doug Fraser (MOF); Stewart Guy (Ministry of Water, Land and Air Protection [MWLAP]); Gordon Haas (former Ministry of Fisheries); Andrew Harcombe (Ministry of Sustainable Resource Management [MSRM]); Eric Lofroth (MWLAP); Brian Nyberg (MOF); Kathy Paige (MWLAP); Susanne Rautio (MWLAP); Richard Thompson (MWLAP); and Liz Williams (MSRM). Of special note is Stewart Guy who demonstrated exceptional communication and project leadership that enabled this project to move forward. Likewise special thanks are due Wayne Erickson for diligently working to ensure the accuracy of all the accounts and for project direction; and Susanne Rautio for her leadership and project management in the early development of this document.

The IWMS Technical Advisory Committee, comprised of stakeholder representatives, reviewed all accounts many times over and in much detail (see Appendix 1 for agency representation). Representatives included David Borth (BC Cattlemen's Association); Colin Campbell (BC Environmental Network); Elaine Golds (BC Endangered Species Coalition/Federation of BC Naturalists); Carol Hartwig (BC Wildlife Federation); Bill Hadden (Federation of BC Woodlot Associations); Dr. Gilbert Proulx (Council of Forest Industries [COFI]); Paula Rodriguez de la Vega (BC Environmental Network); Geoff Scudder (University of British Columbia); Kari Stuart-Smith (COFI); Ken Sumanik (BC Mining Association); and Wayne Wall (Coast Forest & Lumber Association). Special mention is due Colin Campbell, Elaine Golds, Bill Hadden, Carol Hartwig, Dr. Gilbert Proulx, Paula Rodriguez de la Vega, and Wayne Wall for their dedication and thoughtful input throughout the production of this document.

Many other professionals were involved in the development and review of the accounts included in this document. Many experts wrote or reviewed accounts including staff from the MSRM Conservation Data Centre, MWLAP Biodiversity Branch, consultants, and many other organizations. All original authors have been acknowledged in the accounts. Some of the key technical and operational reviewers were Janice Anderson, Ted Antifeau, Harold Armleder, Mike Badry, Suzanne Beauchesne, Robb Bennett, Doug Bertram, Andy Bezgrove, Christine Bishop, Ian Blackburn, Louise Blight, Clait Braun, Andrew Breault, Mark Brigham, Kim Brunt, Doug Burles, Rob Butler, Carmen Cadrin, Richard Cannings, Robert A. Cannings, Syd Cannings, Adolf Ceska, Trudy Chatwin, Dave Christie, Myke Chutter, Alvin Cober, John Cooper, Brenda Costanzo, Ray Coupé, Vanessa Craig, Laura Darling, John Deal, Don Demarchi, George Douglas, Ted Down, Don Doyle, Frank Doyle, Dave Dunbar, Linda Dupuis, Orville Dyer, Wayne Erickson, Tom Ethier, Matt Fairbarns, Tracey Fleming, Dave Fraser, Doug Fraser, Laura Friis, Grant Furness, Judy Godfrey, William Golding, Steve Gordon, Crispin S. Guppy, Les Gyug, Cindy Haddow, Anne Harfenist, Ian Hatter, Don Heppner, Jim Herbers, Anne Hetherington, Jared Hobbs, Robin Hoffos, Tracey Hooper, Jeff Hoyt, Doug Janz, Bruce Johnson, Pierre Johnstone, Doug Jury, Thomas Kaye, Trevor Kinley, Jan Kirkby, Norbert Kondla, Pam Krannitz, John Krebs, Karl Larsen, Ted Lea, Carla Lenihan, Dave Low, Marlene Machmer, Nancy Mahony, Todd Manning, Malcolm Martin, Anre MacIntosh, Dean McGeough, Terry McIntosh, Will MacKenzie, Andy MacKinnon, Gordon Mackinnon, Scott McNay, Katherine Maxcy, Del Meidinger, Rhonda Millikin, Dave Nagorsen, Gary Norris, Penny Ohanjanian, Kristiina Ovaska, Allan Peatt, Mark Phinney, Jim Pojar, Juanita Ptolemy, James Quayle, Leah Ramsay, Sal Rasheed, John Richardson, Hans Roemer, Beth Rogers, Jordan Rosenfeld, Don Russell, Helen Schwantje, Geoff Scudder, Dale Seip, Jon Shepard, Michael G. Shepard, Chris Siddle, Andrea Sissons, Rick Smith, Al Soobotin, Julie Steciw, Andy Stewart, Jeff Stone, Thomas P. Sullivan, John Surgenor, Richard Thompson, Astrid Van Woodenberg, Ross Vennesland, Louise Waterhouse, Debbie Webb, Bryan Webster, Rich Weir, Troy Wellicome, Bill Westover, Liz Williams, Al Wilson, Doug Wilson, Guy Woods, Karen Yearsley, John Youds, Jim Young, and Fred Zwickel.

Maps were prepared by Dennis Demarchi, Diana Demarchi, Annika Livingston with input from authors and species experts including Carmen Cadrin, Wayne Campbell, Ray Coupé, Craig Delong, Wayne Erickson, Don Gayton, Crispin S. Guppy, Jan Kirkby, Ted Lea, Pontus Lindgren, Dave Nagorsen, Jenifer Penny, Jim Pojar, Mike Sarell, and Rick Tucker.

Thanks also to Chris Smith at TM NewMedia for all her hard work and patience. I'm sure it seemed like the changes were endless.

This document represents the efforts of many people and I would like to thank everyone for their contribution and support.

Every effort was made to maintain the integrity of the accounts while still working within the IWMS policy framework.

Kathy Paige
Editor and Compiler

Contents

Introduction

Identified Wildlife are species at risk and regionally important wildlife that the Minister of Water, Land and Air Protection designates as requiring special management attention under the Forest and Range Practices legislation. Under this legislation, the definition of species at risk includes endangered, threatened or vulnerable species of vertebrates, invertebrates, plants and plant communities. Regionally important wildlife include species that are considered important to a region of British Columbia, rely on habitats that are not otherwise protected under FRPA, and are vulnerable to forest and range impacts.

The Identified Wildlife Management Strategy (IWMS) provides direction, policy, procedures and guidelines for managing Identified Wildlife. The goals of the Identified Wildlife Management Strategy are to minimize the effects of forest and range practices on Identified Wildlife, and to maintain their critical habitats throughout their current ranges and, where appropriate, their historic ranges. In some cases, this will entail restoration of previously occupied habitats, particularly for those species most at risk.

The Identified Wildlife Management Strategy applies to Crown forest and range land or private land that is subject to a tree farm or woodlot licence. It addresses forest and range practices regulated under British Columbia's forest legislation. It does not address activities such as recreation, hunting, or poaching. Under the *Wildlife Act*, native terrestrial vertebrates designated as "wildlife" are protected from killing, capture, and harassment except by permit or regulation. The strategy also does not address agriculture or urban development. The IWMS is not intended to be a comprehensive recovery strategy; instead it is intended to be one tool that can be used to manage or recover species habitats. A role of the Ministry of Water, Land and Air Protection is to direct or assist in the development of conservation strategies and recovery plans for species at risk. These plans and strategies can address all requirements for a species' conservation including research and inventory needs, habitat conservation, and regulatory measures.

Identified Wildlife are managed through the establishment of wildlife habitat areas (WHAs), objectives for wildlife habitat areas, and implementation of general wildlife measures (GWMs), or through other management practices specified in strategic or landscape level plans. Wildlife habitat areas are mapped areas that have been approved by the Minister of Water, Land and Air Protection as requiring special management. The purpose of WHAs is to conserve those habitats considered most limiting to a given species. For example, feeding lakes for American White Pelican are considered limiting because they must occur near the breeding site, contain the appropriate prey species, and be relatively free of human disturbance. Breeding sites for Ancient Murrelet are considered limiting because this species returns to the same area each year, breeds in undisturbed old forest habitat, and requires freedom from most mammalian predators.

General wildlife measures describe the management practices that must be implemented within an approved WHA or other spatially defined area. A GWM may limit activities partially (e.g., seasonally) or entirely. General wildlife measures prescribe a level of management appropriate to the conservation status of Identified Wildlife. Management objectives are consistent with the goals and commitments of the Canadian Biodiversity Strategy and provincial goals for the management of wildlife (i.e., as outlined in the Provincial Wildlife Strategy).

For the most part, Identified Wildlife provisions do not address the issues of habitat supply, habitat connectivity, and population viability and other issues such as access management. Such issues should be taken into account during strategic or landscape level planning. Species requiring consideration within strategic level plans are typically wide-ranging species that are sensitive to landscape level changes such as, but not limited to, Badger, Bull Trout, Caribou, Fisher, Grizzly Bear, Marbled Murrelet, Queen Charlotte Goshawk, Spotted Owl, and Wolverine.

The IWMS is a significant step toward responsible stewardship of Identified Wildlife. The management practices included in IWMS are designed to reduce the impacts of forest and range management on Identified Wildlife within targeted social and economic constraints, to balance both socio-economic considerations and conservation of species at risk in British Columbia's managed forest and rangelands. Identified Wildlife Management Strategy provisions in themselves may be insufficient to conserve viable populations of these species throughout their natural ranges in British Columbia. Other strategies and planning, such as Recovery Plans, may be required. The IWMS is intended to be the single-species complement to the broader, coarse-filter provisions of the province's forest and range practices legislation, and strategic land use plans.

Selection of Identified Wildlife

Forest practices legislation authorizes the Minister of Water, Land and Air Protection to establish categories of species at risk and regionally important wildlife, for purposes of establishing wildlife habitat areas, objectives and general wildlife measures that make up the IWMS.

Identified Wildlife are a sub-set of species and plant communities selected from provincially red- (Endangered or Threatened) or blue-listed (Special Concern, Vulnerable) vertebrates and invertebrates; red-listed plants or plant communities; and regionally important wildlife. The Conservation Data Centre (MSRM) is responsible for determining the status of elements in British Columbia. The Conservation Data Centre (January 2003) lists over 1500 animals, plants, and plant communities that are considered to be at risk in British Columbia.

Volume 1 of the Identified Wildlife Management Strategy included 40 Identified Wildlife. These 40 elements represented a portion of the elements at risk and affected by forest and range practices. The original list reflected the efforts of the IWMS interagency Technical Government Working Group to represent a diversity of species and habitats, and included elements from all forest regions. When Volume 1 was released in 1999, a commitment was made to evaluate and rank all species at risk for inclusion within IWMS. In the fall of 1999, a stakeholder Technical Advisory Committee (see Appendix 1) was established to participate and advise in the development of a systematic and defensible method to determine and rank candidates for designation as Identified Wildlife, thus ensuring that the elements most in need and most likely to benefit from inclusion in IWMS were identified. The method for setting priorities was completed in May 2000. For a detailed description of the method and results, see *Setting Priorities for the Identified Wildlife Management Strategy*.

By September 2001, over 800 species at risk that were eligible[1] to be designated as Identified Wildlife had been evaluated for inclusion within IWMS, including all elements in Volume 1 (see Appendix 2 for changes from Volume 1). Of a possible 889 eligible candidates, 246 were considered candidates for further consideration. These were divided into three priority categories: high priority ($n = 52$), intermediate priority ($n = 115$), and low priority ($n = 79$). Priority was determined by considering both the relative conservation risk (i.e., risk of extinction) and relative risk from forest and range management. Conservation risk was determined by considering both the global and provincial status for each element (see Table 1). Conservation risk was the primary factor involved in determining IWMS priority. Relative risk from forest and range management was determined using a coarse risk assessment. The risk assessment considered the main

1 See definition of "species at risk" and "wildlife."

threats causing an element to be at risk as well as the ability of existing habitat protection mechanisms (i.e., parks, FRPA provisions) to address the habitat requirements of each element. In addition the ability to apply Identified Wildlife provisions was also considered (i.e., whether known sites occur on private land where the Forest Practices Code did not apply, or where FRPA will not apply). In this way only those elements negatively affected by forest or range management that occur on Crown land and whose requirements are not adequately addressed by other provisions were selected for designation as Identified Wildlife.

Table 1. Relative conservation risk matrix (1 = highest risk, 15 = lowest risk)

Global rank	Provincial rank				
	S1	S2	S3	S4	S5
G1	1				
G2	2	3			
G3	4	5	6		
G4	7	9	11	13	
G5	8	10	12	14	15

The 2004 list of Identified Wildlife replaces the Volume 1 list. Some elements included in Volume 1 were considered of lower priority, and thus are not included in IWMS at this time (see Appendix 2). These elements may be reconsidered for inclusion later. In addition, while the Minister of Water, Land and Air Protection has legal authority to include regionally important wildlife, this category has not been evaluated at this time and thus is not included in this version. Regionally important wildlife are yellow-listed and were considered of lower priority. In some cases, it may be possible to address the management of specific, localized habitat features for regionally important wildlife using the revised "wildlife habitat feature" mechanism within FRPA. Others will be addressed within IWMS once the list of regionally important wildlife has been updated and approved by the Minister of Water, Land and Air Protection.

Identified Wildlife may be added or rescinded by the Minister of Water, Land and Air Protection. De-designation may occur when the status of a species or community changes. Likewise, the IWMS priority lists will be updated regularly (see *Procedures for Managing Identified Wildlife)*.

Account Development and Review

Accounts summarize the status, life history, distribution, habitat requirements and management standards for Identified Wildlife. Accounts were prepared according to IWMS priority (see Selection of Identified Wildlife). The priorities for account development were elements ranked as having a high priority for inclusion in IWMS. Candidates considered of intermediate priority were also considered, particularly those that are listed nationally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and those that were originally included within IWMS Volume 1.

Additional accounts will be developed on an ongoing basis according to IWMS priority or national listing (COSEWIC). At this time it is anticipated that updates will be made available annually following updates to national and provincial status listings. Provisions may be made for emergency situations, see *Procedures for Managing Identified Wildlife*.

Each account was peer reviewed by a technical reviewer, operational reviewer, and IWMS reviewer. In addition, the IWMS Technical Government Working Group, IWMS stakeholder Technical Advisory Committee, and regional WHA committees reviewed accounts. In many cases other professionals and specialists, especially those involved in setting species management or recovery direction (i.e., Recovery Teams), also reviewed accounts.

Account Template

English Name[2]

Scientific name

Original author[3]

Species or Plant Community Information

Taxonomy

Describes current taxonomic classification. Not included in plant community accounts.

Description

Describes distinguishing features used for identification.

Distribution

Global

Describes global range.

British Columbia

Describes distribution in British Columbia.

Forest regions and districts

Describes distribution according to the Ministry of Forests administrative units (Appendix 3).

Ecoprovince and ecosections

Describes distribution using the ecoregion classification system (Appendix 4), which divides the province into hierarchically and ecologically defined units. Units are defined by climate, physiography, vegetation, and wildlife potential.

Biogeoclimatic units

Describes distribution using the biogeoclimatic ecosystem classification system (Appendix 5). Biogeoclimatic units are defined based on geographically related ecosystems that are distributed within a vegetationally inferred climatic space.

Broad ecosystem units

Describes distribution using the broad ecosystem inventory classification system (Appendix 6). A broad ecosystem unit is a permanent area of the landscape, meaningful to animal use, that supports a distinct kind of dominant vegetative cover, or distinct non-vegetated cover (such as lakes or rock outcrops). Each vegetated unit is defined as including potential (climax) vegetation and any associated successional stages (for forests and grasslands). Broad ecosystem classes have been created based on the integration of vegetation, terrain, topography, and soil characteristics. They are amalgamations of different groups of site series units, as well as site associations. Each BEU may include many distinct climax plant associations. Broad ecosystem units may not be intuitively obvious as many associated habitats may occur in a single unit (i.e., trembling aspen in the Interior Douglas-fir Forest unit).

Elevation

Elevation in metres.

2 English and scientific names largely follow 2003 Resource Information Standards Committee (RISC) standards except for those subspecies without standardized English names. Non-standard English names are noted in quotation marks (e.g., "Queen Charlotte" Goshawk) in the account titles.

3 Accounts were modified from the original drafts as part of the peer review process; IWMS legal, policy, and technical reviews; or recommendations from the IWMS Technical Advisory Committee and regional reviews.

Life History or Plant Community Characteristics

For vertebrates and invertebrates, information on the diet and foraging behaviour, reproduction, site fidelity, home range, and movements is provided. For plants, information on reproduction and dispersal is provided. For plant communities, the structural stage, natural disturbance regime, and fragility of the community are described.

Habitat

Structural stage

Lists structural stages used (Appendix 7) for forested habitats and usually only coniferous species. Structural stage depends on the age class of the ecosystem and vegetation species. For plant community accounts, the structural stage at climax condition is listed.

Important habitats and habitat features

Describes important habitats (e.g., nesting habitat) or habitat features such as wildlife trees (see Appendix 8), coarse woody debris (see Appendix 9), or canopy structure. Not included in plant community accounts. If not specifically described, age follows the definitions of the *Biodiversity Guidebook* (1995 – see http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/biodiv/biotoc.htm). See Appendix 10 for scientific names of commonly referred to tree species.

Conservation and Management

Status

Describes status in British Columbia (*Red, Blue,* or *Yellow*), as determined by the Conservation Data Centre (MSRM). Provincial status is determined and reviewed biannually using the internationally accepted methods of the NatureServe. For more information, see http://wlapwww.gov.bc.ca/wld/documents/ranking.pdf. In summary, elements are ranked from 1 to 5 where 1 is critically imperilled and 5 is secure. Generally, red-listed elements are ranked 1 or 2, blue-listed elements are ranked 3, and yellow-listed elements are ranked 4 or 5.

Status in Canada, as determined by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is also provided. COSEWIC lists species as *Extinct*, *Extirpated*, *Endangered*, *Threatened*, *Special Concern*, *Not at Risk,* or *Data Deficient*. For the most up-to-date lists, see http://www.cosewic.gc.ca.

NatureServe ranks are also provided for British Columbia (BC) and neighbouring jurisdictions including Alaska (AK), Yukon (YK), Northwest Territories (NWT), Alberta (AB), Washington (WA), Idaho (ID), and Montana (MT). National (N) and Global (G) ranks, which reflect an elements' status in Canada or throughout its global range, are also provided when known. This information can indicate the relative importance of conservation within British Columbia and may be used to set regional or provincial management priorities. See Appendix 11 for a description of ranking methodology and codes.

Trends

Population trends

Indicates any noted trends as well as information on abundance, number of known occurrences, and any noted increases, declines, or losses of previously occupied sites.

Habitat trends

Provides general indication of trend (i.e., unknown, likely increasing, likely decreasing, or stable).

Threats

Population threats

Describes threats to populations, such as low reproductive rate, limited dispersal ability, and disease.

Habitat threats

Describes the type of threats to a species' habitat or to a plant community, with particular emphasis on threats from forest or range management practices.

Legal Protection and Habitat Conservation

Summarizes existing legislation, policy, or guidelines that directly protect or manage elements or their habitats with emphasis on FRPA provisions and protected areas.

Identified Wildlife Provisions

Identified wildlife provisions include (1) sustainable resource management and planning recommendations, (2) wildlife habitat areas, and/or (3) general wildlife measures. There is a new provision under FRPA that enables government to set objectives for wildlife habitat areas. This provision is consistent with the shift towards more results based forest practices and enables forest tenure holders to prepare results and strategies for Forest Stewardship Plans that are consistent with objectives for wildlife habitat areas. Objectives for wildlife habitat areas have not been included in the accounts. Procedures for using this new provision are currently under development.

Sustainable resource management and planning recommendations

Recommendations for strategic or landscape level planning. Where appropriate and consistent with current land use plans and future planning processes, these recommendations may be adapted as resource management zone objectives, landscape unit objectives, or land use objectives under a sustainable resource management plan. Where recommendations are not established as legal objectives, they may provide guidance to operational plans such as forest stewardship plans.

Under the 1995 Forest Practices Code (FPC), most Identified Wildlife were managed through the establishment of wildlife habitat areas and did not require specific land use objectives to be established. Three species (Bull Trout, Fisher, and Grizzly Bear) were designated "Higher Level Plan" (HLP) species, and could be managed through the establishment of resource management zone objectives (a type of HLP under the FPC). Under the new forest legislation (FRPA), it is anticipated that, where necessary, strategic or landscape level land use objectives will be established under the *Land Act*. Nonetheless, there may be benefits from planning for the requirements of elements at the strategic and landscape level in that it may be possible to effectively plan for a greater number of species and accommodate connectivity requirements while reducing the incremental impacts to resource industries.

Strategic and landscape level objectives should be considered for species that have large home ranges, occur at low densities, have widely and sparsely distributed limiting habitats, or are sensitive to landscape level disturbances. The requirements of such species must be addressed over large areas, such as regions or watersheds, to effectively manage their populations. There are at least nine species within IWMS for which strategic level objectives should be considered: Badger, Bull Trout, Caribou, Fisher, Grizzly Bear, Marbled Murrelet, Queen Charlotte Goshawk, Spotted Owl, and Wolverine.

The requirements of Identified Wildlife may also be considered within landscape level plans. Generally, the biodiversity goal of landscape level planning is to maintain representative elements (i.e., ecosystems and stand level structural features) across the landscape to increase the probability of maintaining plant communities, species, populations, and community processes over time. However, some elements, particularly those at risk, or those associated with rarer or unique habitats, may not be adequately addressed; thus, it is important to consider more specific requirements or locations of these elements. The FRPA priorities for landscape level planning are old forest and wildlife tree retention. For many Identified Wildlife, recommendations have been made within accounts for old forest or wildlife tree retention to best meet their needs and to assist planning to meet multiple goals (i.e., IWMS, landscape or stand level biodiversity), where possible, and where these goals are compatible. These recommendations are provided for use during landscape level planning and may be developed as legal objectives.

However, in some cases, using landscape level provisions (i.e., old forest) to manage for a single species may compromise the ability to represent the full array of biodiversity elements within the landscape; thus, the implications to other biodiversity elements should always be considered.

Wildlife habitat area

Wildlife habitat areas (WHAs) are areas of limiting habitat that have been mapped and approved by the Minister of Water, Land and Air Protection. Wildlife habitat areas are designed to minimize disturbance or habitat alteration to a species' limiting habitat or to a rare plant community. In most cases, a WHA contains both a core area that is protected from habitat alteration and a management zone to minimize disturbance during critical times or to core area habitats.

Goal

Refers to the overall purpose and management of the WHA.

Feature[4]

Describes an appropriate feature that is required for establishment of a WHA (e.g., active nest area, specific number of breeding pairs or density, maternity colony, or hibernacula). Typically these will be based on limiting habitats, significant concentrations, or those habitats not addressed by coarse filter provisions (i.e., riparian management and landscape unit planning) that are currently occupied. In some cases, WHAs may be recommended for potentially or historically suitable sites for recovery or recruitment. Generally, these will be recommended or endorsed by established recovery teams to meet the requirements of the federal *Species at Risk Act*.

Size

The size of the WHA is estimated; however, these are rough estimates and are subject to site-specific considerations. Further study may determine whether these estimates are adequate to conserve the species or plant community.

4 Not to be confused with "wildlife habitat feature."

Design

Describes the configuration of a WHA including recommendations for inclusion of a core area and a management zone as well as other important considerations for designing a WHA. The general design of WHAs is based on important life history characteristics such as home range size. Typically the WHA will be designed to address key management concerns, whether those are related to habitat or disturbance. Thus, in some cases the design of the WHA will be based on habitat factors and in other cases it may simply be based on distance from an important habitat feature (i.e., a nest) to minimize disturbance at that feature.

General wildlife measures

General wildlife measures (GWMs) direct forest and range practices within a WHA, specified ecosystem unit, or other spatially defined area, and have been approved by the Minister of Water, Land and Air Protection.

Goals

List of the overall objectives and desired results for management within a WHA or otherwise defined area.

Measures

General wildlife measures can address forest and range practices carried out under the Forest Practices Code (during transition) or under FRPA. The practices include road construction, road maintenance, livestock grazing, hay cutting, pesticide use, and timber harvesting. Practices have been grouped under the following headings: access, harvesting and silviculture, pesticides, range, and recreation. A GWM may limit activities partially or entirely. A GWM may apply to the core area or management zone of a WHA. When neither are specified, the GWM applies to the entire WHA. All general wildlife measures may be modified case by case by the Minister of Water, Land and Air Protection or designate. For more information, see *Procedures for Managing Identified Wildlife.*

Additional Management Considerations

Recommendations for managing an area adjacent to a WHA or for managing activities that are not regulated under the FRPA.

Information Needs

Suggested list of three main research or inventory priorities.

Cross References

List of other Identified Wildlife whose requirements and distribution may overlap with the species or plant community under consideration.

References Cited

Personal Communications

Identified Wildlife by Forest Region

See Appendix 13 for lists of Identified Wildlife by Southern Interior forest districts.

English name	Scientific name	Coast	Southern Interior	Northern Interior
	Plant Communities			
Alkali Saltgrass herbaceous vegetation	*Distichlis spicata var. stricta* herbaceous vegetation		x	
Antelope Brush/Bluebunch Wheatgrass	*Purshia tridentata/ Pseudoroegneria spicata*		x	
Antelope Brush/ Needle-and-Thread Grass	*Purshia tridentata/ Hesperostipa comata*		x	
Douglas-fir/Alaska Oniongrass	*Pseudotsuga menziesii/ Melica subulata*	x		
Douglas-fir/Common Juniper/Cladonia	*Pseudotsuga menziesii/ Juniperus communis/Cladonia*		x	
Douglas-fir/Dull Oregon-grape	*Pseudotsuga menziesii/ Mahonia nervosa*	x		
Douglas-fir/Snowberry/Balsamroot	*Pseudotsuga menziesi/ Symphoricarpos albus/ Balsamorhiza sagittata*		x	
Hybrid White Spruce/Ostrich Fern	*Picea engelmannii* x *glauca/ Matteuccia struthiopteris*		x	x
Ponderosa Pine/Bluebunch Wheatgrass – Silky Lupine	*Pinus ponderosa/ Pseudoroegneria spicata – Lupinus sericeus*		x	
Vasey's Big Sage/Pinegrass	*Artemisia tridentata* ssp. *vaseyana/ Calamagrostis rubescens*		x	
Water Birch – Red-Osier Dogwood	*Betula occidentalis – Cornus stolonifera*		x	
Western Hemlock – Douglas-fir /Electrified Cat's-Tail Moss	*Tsuga heterophylla – Pseudotsuga menziesii/ Rhytidiadelphus triquetrus*	x	x	
Western Redcedar/Devil's-club/ Ostrich Fern	*Thuja plicata/Oplopanax horridus/ Matteuccia struthiopteris*			x
Western Redcedar – Douglas-fir/ Devil's-club	*Thuja plicata – Pseudotsuga menziesii/ Oplopanax horridus*	x	x	
Western Redcedar – Douglas-fir/ Vine Maple	*Thuja plicata – Pseudotsuga menziesii/Acer circinatum*	x	x	
	Plants			
Scouler's Corydalis	*Corydalis scouleri*	x		
Tall Bugbane	*Cimicifuga elata*	x		
	Invertebrates			
Gillett's Checkerspot	*Euphydryas gillettii*		x	
Johnson's Hairstreak	*Loranthomitoura johnsoni*	x		
Quatsino Cave Amphipod	*Stygobromus quatsinensis*	x		
Sonora Skipper	*Polites sonora*	x	x	
Sooty Hairstreak	*Satyrium fuliginosum*		x	

English name	Scientific name	Coast	Southern Interior	Northern Interior
	Vertebrates			
Fish				
Bull Trout	*Salvelinus confluentus*	x	x	x
Vananda Creek Limnetic and Benthic Sticklebacks	*Gasterosteus* spp. 16 and 17	x		
"Westslope" Cutthroat Trout	*Oncorhynchus clarki lewisi*		x	introduced
Amphibians				
Coastal Giant Salamander	*Dicamptodon tenebrosus*	x		
Coastal Tailed Frog	*Ascaphus truei*	x	x	x
Coeur d'Alene Salamander	*Plethodon idahoensis*		x	
Great Basin Spadefoot	*Spea intermontana*		x	
Northern Leopard Frog	*Rana pipiens*	introduced	x	
Red-legged Frog	*Rana aurora*	x		
Rocky Mountain Tailed Frog	*Ascaphus montanus*		x	
Tiger Salamander	*Ambystoma tigrinum*		x	
Reptiles				
"Great Basin" Gopher Snake	*Pituophis catenifer deserticola*		x	
Racer	*Coluber constrictor mormon*	x	x	
Western Rattlesnake	*Crotalus oreganus*		x	
Birds				
American White Pelican	*Pelecanus erythrorhynchos*	x	x	x
Ancient Murrelet	*Synthliboramphus antiquus*	x		
Bay-breasted Warbler	*Dendroica castanea*			x
Black-throated Green Warbler	*Dendroica virens*			x
Burrowing Owl	*Athene cunicularia*		x	
Cape May Warbler	*Dendroica tigrina*			x
Cassin's Auklet	*Ptychoramphus aleuticus aleuticus*	x		
"Columbian" Sharp-tailed Grouse	*Tympanuchus phasianellus columbianus*		x	x
Connecticut Warbler	*Oporornis agilis*			x
Flammulated Owl	*Otus flammeolus idahoensis*		x	
Grasshopper Sparrow	*Ammodramus savannarum perpallidus*		x	
Great Blue Heron	*Ardea herodias fannini, Ardea herodias herodias*	x	x	x
"Interior" Western Screech-Owl	*Otus kennicottii macfarlanei*		x	
Lewis's Woodpecker	*Melanerpes lewis*	historical	x	
Long-billed Curlew	*Numenius americanus*		x	x
Marbled Murrelet	*Brachyramphus marmoratus*	x		x
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*			x
Prairie Falcon	*Falco mexicanus*		x	
"Queen Charlotte" Goshawk	*Accipiter gentilis laingi*	x		
"Queen Charlotte" Hairy Woodpecker	*Picoides villosus picoideus*	x		
"Queen Charlotte" Northern Saw-whet Owl	*Aegolius acadicus brooksi*	x		

English name	Scientific name	Coast	Southern Interior	Northern Interior
Sage Thrasher	*Oreoscoptes montanus*		x	
"Sagebrush" Brewer's Sparrow	*Spizella breweri breweri*		x	
Sandhill Crane	*Grus canadensis*	x	x	x
Short-eared Owl	*Asio flammeus*	x	x	x
Spotted Owl	*Strix occidentalis*	x	x	
"Vancouver Island" Northern Pygmy-Owl	*Glaucidium gnoma swarthi*	x		
"Vancouver Island" White-tailed Ptarmigan	*Lagopus leucurus saxatilis*	x		
White-headed Woodpecker	*Picoides albolarvatus*		x	
Williamson's Sapsucker	*Sphyrapicus thyroideus nataliae, Sphyrapicus thyroideus thyroideus*		x	
Yellow-breasted Chat	*Icteria virens*	x	x	
Mammals				
Badger	*Taxidea taxus jeffersonii*	extreme east only	x	
Bighorn Sheep	*Ovis canadensis*		x	x
Caribou (mountain, boreal and northern ecotypes)	*Rangifer tarandus caribou*	x	x	x
Fisher	*Martes pennanti*	x	x	x
Fringed Myotis	*Myotis thysanodes*		x	
Grizzly Bear	*Ursus arctos*	x	x	x
Keen's Long-eared Myotis	*Myotis keenii*	x		
Pacific Water Shrew	*Sorex bendirii*	x		
Spotted Bat	*Euderma maculatum*		x	
"Vancouver Island" Common Water Shrew	*Sorex palustris brooksi*	x		
Vancouver Island Marmot	*Marmota vancouverensis*	x		
Wolverine	*Gulo gulo luscus, Gulo gulo vancouverensis*	x	x	x

Invertebrates

Gillett's Checkerspot

Euphydryas gillettii

Original prepared by R.J. Cannings

Species Information

Taxonomy

Gillett's Checkerspot is in the order Lepidoptera and the family Nymphalidae. Five species of *Euphydryas* occur in Canada, four of these in British Columbia. No subspecies of *E. gillettii* are recognized (Layberry et al. 1998).

Description

Gillett's Checkerspot adults are the most distinctive of the four *Euphydryas* species found in British Columbia. Wingspan 36–45 mm. Upperside of wings is black with a band of large orange-red spots and smaller white spots. Broad orange-red band close to the margin of each wing separates this species from other *Euphydryas* species. Underside of wings similar to upperside as is typical for the genus. Mature larva is spiny and dingy yellow with a lemon-yellow dorsal stripe and white lateral stripes. Dorsal spines are yellow, lateral spines are black (Layberry et al. 1998).

Distribution

Global

Found only in the Rocky Mountains of Canada and the northern United States, from Nordegg, Alberta, south to Wyoming and Idaho (Layberry et al. 1998).

British Columbia

Known from southeastern British Columbia: Procter Lake, MacGillivray, and Flathead (Layberry et al. 1998; N.G. Kondla, pers. comm.).

Forest region and district

Southern Interior: Rocky Mountain

Ecoprovinces and ecosections

SIM: COC, ELV, FLV

Biogeoclimatic units

MS: dk

Broad ecosystem units

SD, SF, WR

Elevation

1200–2100 m

Life History

Diet and foraging behaviour

Adults obtain nectar from yellow composite flowers (Asteraceae) (Bird et al. 1995). Larvae usually feed upon black twinberry (*Lonicera involucrata*), but other plants are occasionally used in spring after hibernation (Layberry et al. 1998).

Reproduction

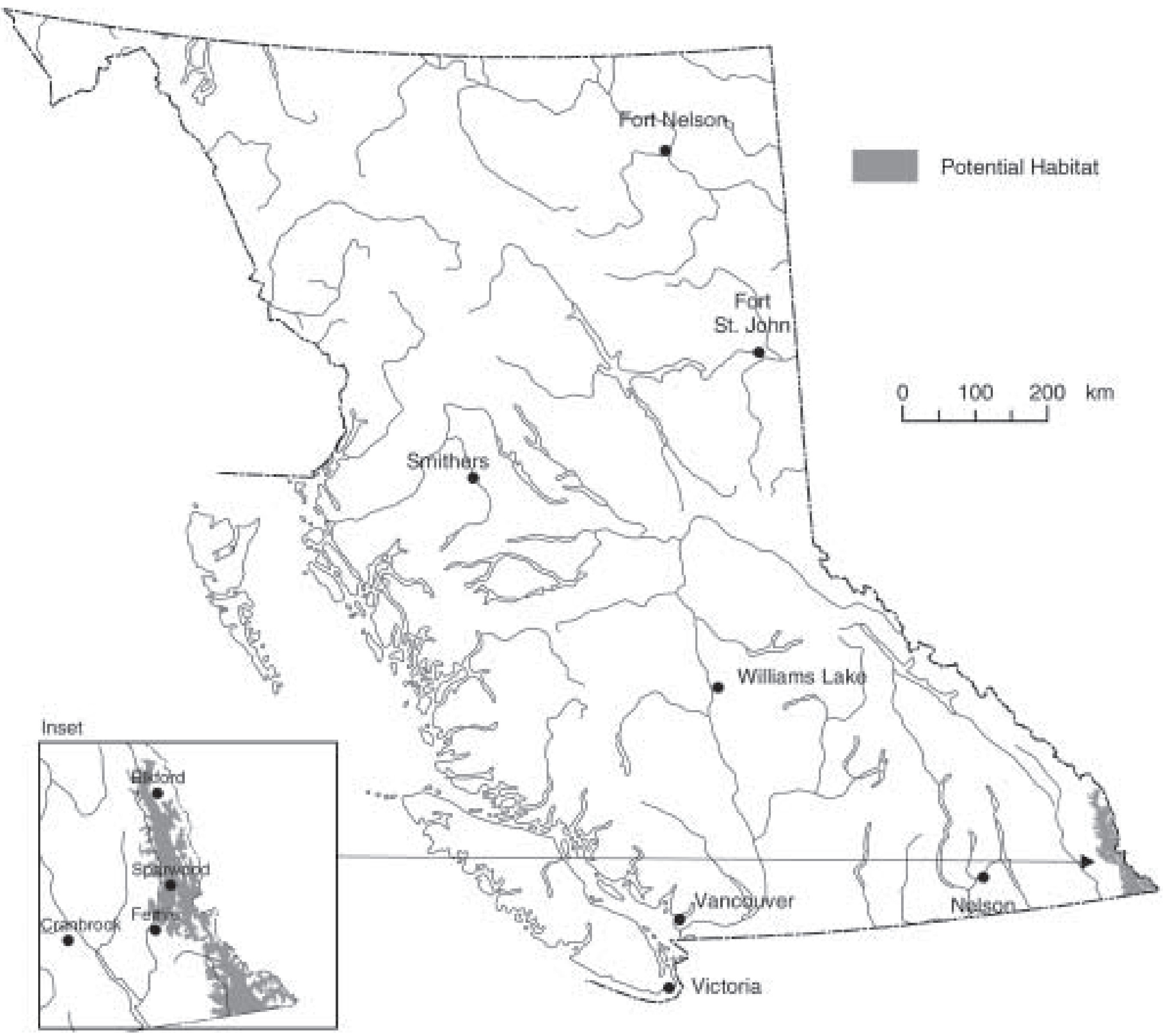
Gillett's Checkerspot often occurs near streams in forested habitats. Adults (butterflies) may be found in mid-summer (mid-June to early August; most records in late June and July) and produce one brood per year (Williams et al. 1984). Females lay their eggs on black twinberry whenever possible, but will occasionally use other plants, such as snowberry (*Symphoricarpos* spp.) and valerians (*Valeriana* spp.) (Williams et al. 1984; Bird et al. 1995). Larvae overwinter in third or fourth instar, developing the following spring to fifth instar which then pupates and emerges as adult in June (Williams et al. 1984).

Site fidelity and home range

Unknown. C.S. Guppy (pers. comm.) suggests that the home range is likely small (<1 km) and site fidelity high for most individuals.

Gillett's Checkerspot

(Euphydryas gillettii)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Movements and dispersal

Adults of some *Euphydryas* species are weak fliers living in small, highly localized colonies. It is not believed this is the case in British Columbia (N.G. Kondla, pers. comm.; C.S. Guppy, pers. comm.)

Habitat

Structural stage

2: herb
3: shrub/herb

Important habitats and habitat features

Usually, the most critical element in the habitat requirements of any butterfly species is the presence and abundance of its larval food plant. Gillett's Checkerspot requires black twinberry for egg-laying and larval development though it will also use other *Lonicera* species, snowberry, lousewort (*Pedicularis*), and valerian (Williams et al. 1984; Williams 1988; Bird et al. 1995). Williams et al. (1984) characterize ideal habitat in the American Rockies as Engelmann spruce woodland along streams with abundant shrub cover, primarily black twinberry. However, Williams (1988) found that many sites occupied by Gillett's Checkerspots have been disturbed, commonly by fire, and lodgepole pine can be the leading tree species at these sites. Females search for sunlit twinberries on which to lay eggs, so areas with high willow cover or other shading canopy are less desirable (Williams 1988). Fire-opened sites gradually proceed to closed forest, and populations at these sites disappear (Williams 1988, 1995).

Williams (1988) emphasized that all occupied sites he examined ($n = 29$) were wet, most with small streams and others without streams but marshy. He also found a relationship between the presence of large colonies and the abundance of nectar sources, primarily composite flowers in the genera *Aster*, *Senecio*, and *Agoseris*.

Conservation and Management

Status

The Gillett's Checkerspot is on the provincial *Blue List* in British Columbia. Its status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	ID	MT	Canada	Global
S2S3	S2	S?	S3	N2	G2G3

Trends

Population trends

Gillett's Checkerspots are normally found in small, discrete colonies that are relatively stable from year to year (Williams et al. 1984; Williams 1995). Gillett's Checkerspot is known from at least 10 sites, all in the extreme southeastern corner of the province. There may be more sites and the total population is estimated to be 3000 or more individuals (Guppy and Kondla 2000). Williams (1995, p. 183) states that "this species forms metapopulations in which local extinctions and recolonizations occur infrequently."

Habitat trends

Unknown.

Threats

Population threats

This species has a relatively restricted distribution, which increases the risk of extirpation.

Habitat threats

The main threats to this species' habitat are forest practices and heavy livestock grazing. Both activities may damage or destroy certain sites or individuals (e.g., through incidental cattle ingestion of highly concentrated egg clusters or trampling of black twinberry) that are critical to the species' survival in a local area. As this species occurs in highly localized populations restricted to the preferred larval food plant (black twinberry), changes to local habitat that affect black twinberry (e.g., canopy closure) will also impact the butterfly.

Legal Protection and Habitat Conservation

Butterflies are not protected under the provincial *Wildlife Act*. They are protected from collection in national and provincial parks.

Several sites occur within Elk Lakes Provincial Park (Guppy and Kondla 2000) and they may occur in Akamina Kishinena Provincial Park.

Results based code riparian guidelines may also protect the species to some extent, although Gillett's Checkerspot is more often associated with very small streams that receive less protection than the larger, fish-bearing streams. Range use plans may also be used to address the habitat requirements of this species when mitigation measures are incorporated.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain breeding and larval foraging habitat to prevent local extirpations.

Feature

Establish WHAs at known breeding sites that are characterized by moist, open habitats with ample black twinberry.

Size

Typically between 5 and 10 ha but size will ultimately depend on the extent of suitable habitat.

Design

The WHA should encompass the perimeter of the colony plus 100 m.

General wildlife measures

Goals

1. Maintain an open forest habitat with ample growth of black twinberry for larval development.
2. Maintain scattered trees and composite flowers (nectar sources).

Measures

Access

- Do not construct roads.

Harvesting and silviculture

- Design harvest and silviculture treatments to maintain open moist forest; avoid treatments and prescriptions that will result in closed canopy.
- Harvest in winter with an adequate snowpack to minimize damage to twinberry shrubs.

Pesticides

- Do not use pesticides.

Range

- Set desired plant community to include black twinberry and larval food plants.
- Control livestock grazing (e.g., timing, distribution, and level of use) to prevent degradation or trampling of black twinberry. Where there is no other practicable option, fencing may be required to control livestock use. Consult MWLAP for fencing arrangements.
- Do not place livestock attractants within WHA.

Recreation

- Do not construct recreational trails unless this can be accomplished without reducing the cover of black twinberry.

Additional Management Considerations

Use non-herbicide weed control methods adjacent to WHA and retain larval food plants and nectar sources. Where herbicide-based control is necessary, measures such as hand wick application or spot treatments should be taken to protect non-target species (including black twinberry).

Maintain riparian corridors with intact shrubbery and open forest to aid the dispersal of checkerspots between the localized breeding sites.

Information Needs

1. Inventory black twinberry sites for presence of Gillett's Checkerspot.
2. Distribution and abundance studies of known populations.

Cross References

Grizzly Bear

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Sonora Skipper

Polites sonora

Original prepared by R.J. Cannings

Species Information

Taxonomy

The Sonora Skipper is in the order Lepidoptera and the family Hesperiidae. The Sonora Skipper is one of six species in the genus *Polites* known from British Columbia; 16 species are known to occur in North America. Only one subspecies *P. sonora sonora*, occurs in British Columbia (Guppy and Shepard 2001). The taxonomy of this subspecies is currently under review. Layberry et al. (1998) assigned British Columbia specimens to *P. sonora siris*, but Guppy and Shepard (2001) show *P. sonora siris* as being restricted to western Washington State.

Description

A small orange (male) or orange-brown (female) skipper (wingspan 25–27 mm) with distinctive "crisp" crescent-shaped medial band of pale spots on the underside of the hindwing (Layberry et al. 1998; Guppy and Shepard 2001). The egg is round and light green; third instar larva is 5 mm long and grey green with many fine black scales (Guppy and Shepard 2001).

Distribution

Global

Found in southwestern British Columbia through Washington, Oregon, and California to Mexico; also in the American Rocky Mountains from Idaho and western Montana south to Colorado and northern Arizona (Opler et al. 1995).

British Columbia

This species is only confirmed from three locations in British Columbia: Crater Mountain, Manning Provincial Park, and Hope Mountain. This species may also occur near Merritt.

Forest region and districts

Southern Interior: Cascades, Okanagan Shuswap (Penticton)

Coast: Chilliwack

Ecoprovinces and ecosections

COM: EPR

SOI: OKR, STU

Biogeoclimatic units

BG: xh1

IDF: dk1, dk2, xh1

MH: mm

PP: xh1

Broad ecosystem units

BS, DF, DP, MF, PP

Elevation

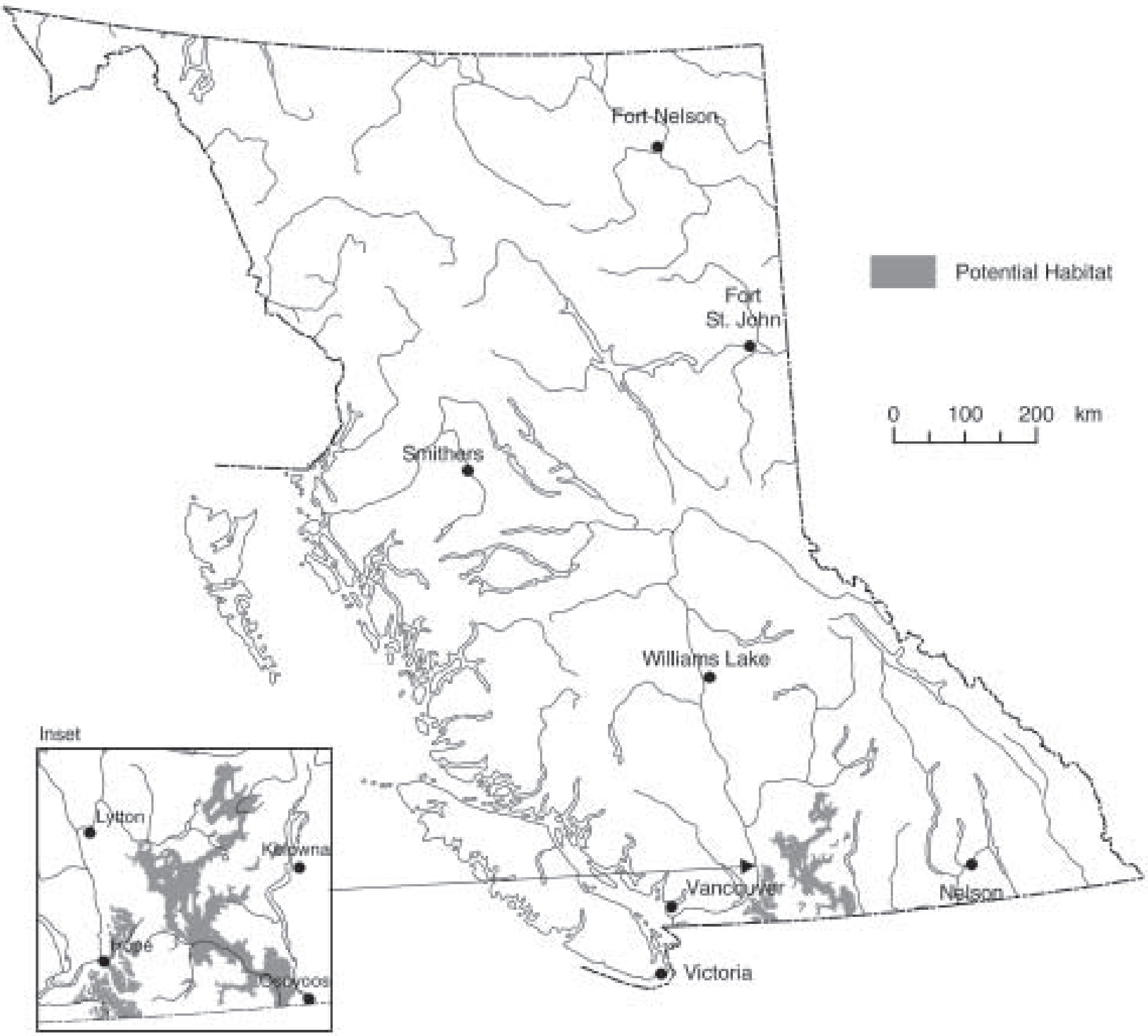
1160–1675 m

Life History

Diet and foraging behaviour

Larvae feed on grasses. Newcomer (1967) successfully reared this species on Idaho fescue, *Festuca idahoensis*. Adults nectar on a variety of flowers, including thistles (Opler et al. 1995).

Sonora Skipper
(Polites sonora)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Reproduction

Eggs are laid in mid- to late June in central Washington and hatch about 8 days later. Larvae reach the third instar stage by the end of July (Newcomer 1967). Based on habits of closely related species and timing of larval development (Newcomer 1967), this species probably overwinters as pupae, at least at lower elevations. Populations at higher elevations (ca. 1500 m) may overwinter as third or fourth instar larvae, since adults do not fly at those altitudes until July (J.H. Shepard, pers. comm.).

Site fidelity

Sonora Skippers are found repeatedly in the same meadows year after year (C.S. Guppy, pers. comm.).

Home range

No data.

Dispersal and movements

No data.

Habitat

Structural stage

2: herb

Important habitats and habitat features

Small meadows and forest clearings (Dornfield 1980). Newcomer (1967) suspected that Idaho fescue was an important larval food plant.

Conservation and Management

Status

The Sonora Skipper is on the provincial *Red List* in British Columbia. Its status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	OR	WA	Canada	Global
S1	SU	S5	S?	S4	N1	G4

Trends

Population trends

Trend is not known. Only two sites are accurately recorded; Guppy and Kondla (2000) estimate that the species may occur in a total of five sites in British Columbia with a provincial population of no more than 3000 individuals.

Habitat trends

Grassland habitats in general are declining in quality and area due to urban and agricultural development, forest encroachment, and in-growth.

Threats

Population threats

This species has a very small range in British Columbia and is only confirmed from two locations. A restricted distribution and possible lack of genetic exchange increases the risk of extirpation.

Habitat threats

This species depends on grassy meadows; thus, the primary threats in British Columbia may include heavy livestock grazing, invasion of grasslands by invasive species, and fire suppression and resulting forest encroachment. Forest harvesting also poses a threat if it involves degradation of grass meadow habitat (Guppy and Kondla 2000).

Legal Protection and Habitat Conservation

Butterflies are not protected under the provincial *Wildlife Act*. They are protected from collection in national and provincial parks.

Manning Provincial Park provides some habitat protection for this species (Guppy and Kondla 2000). Cathedral Provincial Park and the newly announced Snowy Mountain Protected Area likely contain suitable habitat as well.

Under the results based code, range use plans may be used to address the habitat requirements of this species when mitigation measures are incorporated.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain breeding habitat and larval forage species (grasses) to prevent local extirpations.

Feature

Establish WHAs at known locations where species regularly occurs.

Size

Typically between 15–25 ha but will depend on area of suitable habitat.

Design

The WHA should include grassland and forest openings within the vicinity of the known site; adults are generally found near the oviposition sites (C.S. Guppy, pers. comm.). Where possible the WHA should encompass the meadow area or suitable habitat patch.

General wildlife measures

Goals

1. Maintain grassland at late seral to climax condition with healthy grass plants.
2. Maintain abundance and health of larval food plant (bunchgrasses, Idaho fescue).
3. Prevent or minimize introduction and spread of invasive species.
4. Prevent soil disturbance.
5. Control forest encroachment and in-growth.

Measures

Access

- Do not construct roads.

Harvesting and silviculture

- Minimize soil disturbance.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to maintain the desired plant community, desired stubble height and browse utilization. The desired plant community is that of the natural grassland at late seral to climax condition.
- Control livestock grazing (i.e., timing, distribution, and level of use) to minimize soil disturbance and the introduction of invasive species.
- Do not place livestock attractants within WHA.

Additional Management Considerations

Controlled prescribed burns and/or silvicultural treatments may be necessary to maintain suitable grassland habitats for Sonora Skippers.

Good range management practices should be sufficient to maintain corridors for dispersal and prevent introduction and spread of invasive species.

Information Needs

1. Inventory of appropriate habitat in the north Cascades of British Columbia.
2. Basic ecological information, such as flight period, larval food plants, and overwintering strategy
3. Access effects of livestock grazing, invasive species and forest encroachment.

Cross References

Bighorn Sheep, Flammulated Owl

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Shepard, J. 2001. Consultant, Pullman, Wash.

Sooty Hairstreak

Satyrium fuliginosum

Original prepared by R.J. Cannings

Species Information

Taxonomy

The Sooty Hairstreak is in the order Lepidoptera and the family Lycaenidae. The Sooty Hairstreak (also known as the Sooty Gossamer Wing) is one of 11 species of *Satyrium* hairstreaks found in Canada. Five subspecies of Sooty Hairstreak are recognized. Only *S. fuliginosum semiluna* is known from British Columbia (Guppy and Shepard 2001). However, the taxonomy of this species is currently under review (P. Opler pers. comm. to N.G. Kondla).

Description

A small hairstreak (wingspan 24–30 mm) with uniform grey-brown upperwings and small diffuse black, white-rimmed spots on the sooty-appearing brown underwings (Guppy and Shepard 2001).

Distribution

Global

Restricted to western North America; from southern British Columbia and extreme southwestern Alberta south to central California, northern Nevada, Utah, and northwestern Colorado (Opler et al. 1995; Guppy and Shepard 2001).

British Columbia

Known from two sites in the southern Okanagan Valley in British Columbia: Anarchist Mountain (three separate collections) (St. John 1995; Guppy and Kondla 2000) and one collection from Keremeos (Layberry et al. 1998).

Forest region and district

Southern Interior: Okanagan Shuswap (Penticton)

Ecoprovinces and ecosections

SOI: OKR, SOB, SOH

Biogeoclimatic units

BG: xh1
PP: dh1 (to SOB and SOH), xh1

Broad ecosystem units

AB, BS, SS

Elevation

400–800 m

Life History

Diet and foraging behaviour

The Sooty Hairstreak occurs on dry, brushy slopes where lupines, the larval host plant, occur. *Lupinus arbustus* occurs within the known range of this butterfly in British Columbia (Guppy and Shepard 2001). Adults have been seen nectaring at mock orange (*Philadelphus lewisii*) flowers (Bird et al. 1995). The known flight period in British Columbia is late May to early July (Guppy and Shepard 2001).

Reproduction

Females lay eggs under lupine plants (Bird et al. 1995); the eggs apparently overwinter (as do eggs of the other *Satyrium* species); larvae feed on lupines through the spring.

Site fidelity

No data.

Home range

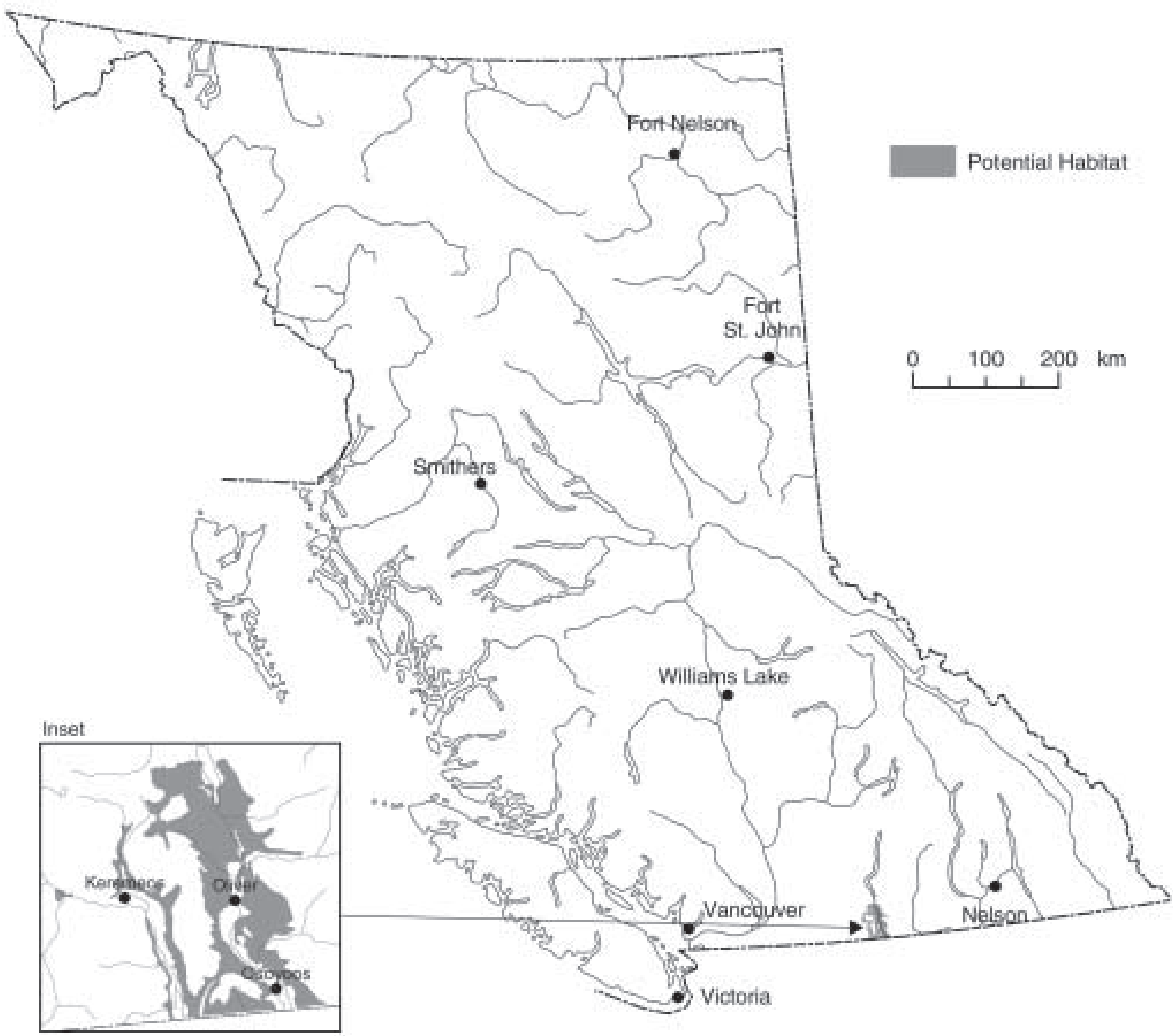
No data.

Dispersal and movements

Probably low dispersal ability (C.S. Guppy, pers. comm.).

Sooty Hairstreak

(Satyrium fuliginosum)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Habitat

Structural stage

2: herb

Important habitats and habitat features

A healthy shrub-steppe environment with adequate densities of lupines (*Lupinus* spp.) is essential.

Conservation and Management

Status

The Sooty Hairstreak is on the provincial *Red List* in British Columbia. Its status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	OR	WA	Canada	Global
S1	S?	S4	S?	S4	N1N2	G4

Trends

Population trends

Not known. Sooty Hairstreak is considered uncommon to vulnerable throughout its range (Layberry et al. 1998). Guppy and Kondla (2000) list three occurrences in British Columbia, all in the Anarchist Mountain, Osoyoos area. Layberry et al. (1998) note an occurrence at Keremeos. One or two more occurrences are likely and the total provincial population is probably less than 3000 (C.S. Guppy, pers. comm.).

Habitat trends

More than 200 ha of suitable habitat on Anarachist Mountain have been converted to vineyards within a 2-year period and much of the eastern slopes are being subdivided for rural housing. At least one of these holdings has been fenced and is being grazed by domestic goats. Similar development pressures exist on most privately held habitat in the south Okanagan and Similkameen valleys, as well as on lands controlled by the local First Nations.

Threats

Population threats

This species has a very restricted distribution in British Columbia and is only known from two sites (four collections), which increases the risk of extirpation.

Habitat threats

Three of the four collections in British Columbia are from Anarchist Mountain just east of Osoyoos; all are threatened by housing or agricultural developments such as vineyards.

Legal Protection and Habitat Conservation

Butterflies are not protected under the provincial *Wildlife Act*. They are protected from collection within national and provincial parks.

No known sites are protected, although the recently created South Okanagan Grasslands Provincial Park protects suitable habitat and may have a small undiscovered population.

Under the results based code, range use plans may be used to address the habitat requirements of this species when mitigation measures are incorporated.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain breeding habitat and larval forage species to prevent local extirpations.

Feature

Establish WHAs at known locations.

Size

Typically between 15 and 25 ha but will depend on area of suitable habitat.

Design

The WHA should be centred on (but not necessarily circular) the known site and encompass the area of suitable habitat (bunchgrass-shrub steppe with lupines).

General wildlife measures

Goals

1. Maintain sufficient cover of lupines (breeding habitat).
2. Minimize soil disturbance.
3. Minimize disturbance to adults and larvae.
4. Maintain native vegetation.
5. Minimize introduction and spread of invasive species.

Measures

Access

- Do not construct roads unless there is no other practicable option.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to maintain desired plant community, desired stubble height, and browse utilization.
- Do not place livestock attractants within WHA.
- Control livestock grazing (timing, distribution, and level of use) to minimize soil disturbance and the introduction of invasive species.

Additional Management Considerations

Minimize spread of invasive species in and around the WHA. Non-herbicide weed control methods are preferred. Where herbicide-based control is approved, measures must be taken to protect non-target plant species (for example, hand wick application and spot treatments of individual weeds).

Do not use fire on Sooty Hairstreak WHAs except when part of a habitat restoration/enhancement prescription for Sooty Hairstreak.

Information Needs

1. Inventory appropriate habitat in the shrub-steppes of southern British Columbia (Thompson-Okanagan-Similkameen) of *S. fuliginosum* (and its larval host plants) in British Columbia, particularly its status in the new South Okanagan Grasslands Provincial Park.
2. Basic ecological information, especially the effect of grazing on reproductive success.

Cross References

Burrowing Owl, Grasshopper Sparrow, Great Basin Spadefoot, "Great Basin" Gopher Snake, Long-billed Curlew, Racer, "Sagebrush" Brewer's Sparrow, Sage Thrasher, Tiger Salamander, Western Rattlesnake

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Fish

Bull Trout

Salvelinus confluentus

Original[1] prepared by Jay Hammond

Species Information

Taxonomy

As a member of the genus *Salvelinus,* Bull Trout (family Salmonidae) are not a true trout, but rather a char. Bull Trout have a complicated taxonomic history, in part due to Bull Trout and Dolly Varden (*Salvelinus malma*) being considered for a time as the same species, until Cavender (1978) identified a number of morphological characteristics of the skull and distribution patterns that suggested the two species were actually distinct. Haas and McPhail (1991) also concluded that Bull Trout and Dolly Varden are separate species, based on principal component analyses of meristic and morphometric data. In addition, genetic studies of the genus *Salvelinus*, using ribosomal DNA (Phillips et al. 1992; Phillips et al. 1994) and mitochondrial DNA (Grewe et al. 1990), supported the findings of the morphological studies. In fact, in each of these genetic studies, Bull Trout and Dolly Varden were not as closely related to each other as they were to other char species. This separation between the two species has been recognized by the American Fisheries Society since 1980 (Robins et al. 1980).

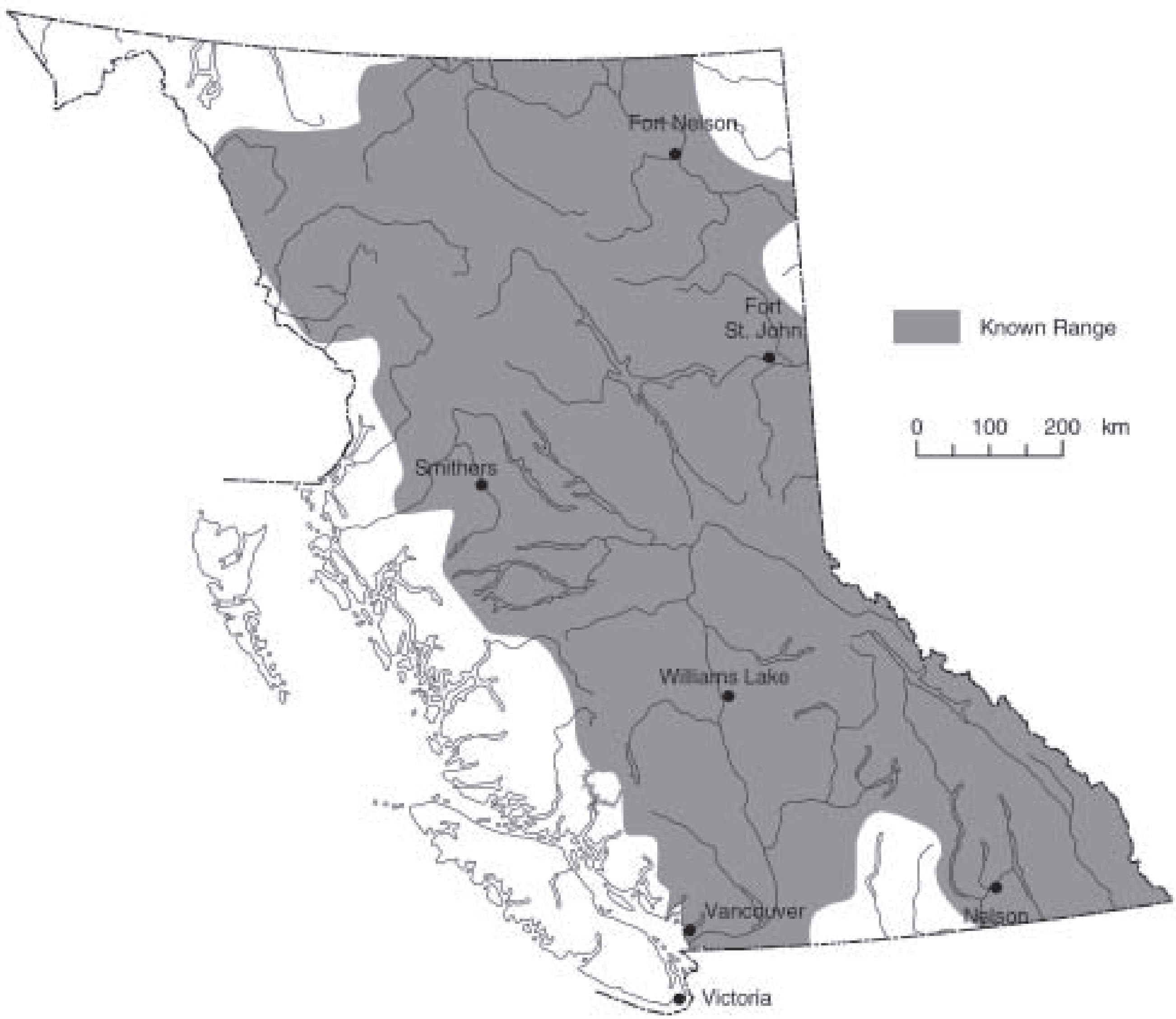
The taxonomic history is also complicated by records of hybridization between Bull Trout and Dolly Varden, where these species occur in sympatry (McPhail and Taylor 1995; Baxter et al. 1997). However, Hagen (2000) undertook a detailed study in the Thutade watershed, where Bull Trout and Dolly Varden ranges overlap, and concluded that ecological factors and niche selection were supporting reproductive isolation between the two species and that the hybrids were generally not as fit as either parent species in this environment. Taylor et al. (2001) noted that, despite the gene flow brought about by hybridization, Bull Trout and Dolly Varden are clearly distinct gene pools. The maintenance of this distinction, in sympatry and in the face of gene flow, was considered conclusive in meeting the test of biological species.

There are no recognized subspecies of Bull Trout. However, Taylor et al. (1999) identified two evolutionarily distinct units—coastal and interior—based on range-wide mitochondrial DNA studies. In British Columbia, the coastal unit is concentrated in the lower Fraser (downstream of Hell's Gate) and other south coast rivers such as the Squamish. This group likely invaded British Columbia from the Chehalis refuge and may extend farther north up the coast; however, sample coverage was poor in that area. The interior unit, occupying the remainder of the species' range in British Columbia, likely invaded British Columbia from the Columbia refuge.

Taylor et al. (1999) also noted that genetic diversity in Bull Trout was principally found between (rather than within) populations and stressed the importance of maintaining as many populations as possible to conserve the species. Costello et al. (2003) used microsatellite DNA to examine genetic structure at the basin level. Their results supported the earlier work and demonstrated high levels of population subdivision within basins. Importantly, above-barrier populations were found to contain locally rare alleles, suggesting the possibility of distinct founding events. These results suggest that recolonization of extirpated populations from neighbouring watersheds may not be sufficient to maintain the species diversity.

1 Volume 1 account prepared by J. Ptolemy.

Bull Trout
(Salvelinus confluentus)



Note: This map represents a broad view of the distribution of habitat used by this species. The map is based on current knowledge of the species' distribution. This species may or may not occur in all areas indicated.

Description

Bull Trout have a large head and jaws in relation to their long, slender body (Post and Johnston 2002). Cavender (1978) reported that Bull Trout have a larger, broader, and flatter head, and a more ventrally flattened body, than Dolly Varden. Bull Trout colouration ranges from green to greyish-blue, with lake-resident fish often displaying silvery sides (Nelson and Paetz 1992; Berry 1994). The dorsum and flanks are spotted with pale yellowish-orange spots. The absence of black spots on the dorsal fin distinguishes Bull Trout from other species of char and trout that are native to western Canada (Berry 1994). The pelvic and anal fins of mature male Bull Trout develop a tri-colour sequence beginning with white leading edges progressing to a black band fading to grey and ending with a bright orange trailing edge. Mature female Bull Trout exhibit a similar pelvic and anal fin colouration, though the colour contrast is not as pronounced as that of male fish (McPhail and Murray 1979).

Bull Trout are large fish relative to other char and trout species (Ford et al. 1995). Stream-resident populations often reach maturity and maximum length at 20–33 cm (Robinson and McCart 1974; Craig and Bruce 1982; Pollard and Down 2001). The maximum size of mature Bull Trout has been reported to vary from 20 to 40 cm in some habitats (Bjornn 1961; McPhail and Murray 1979). However, Pollard and Down (2001) also reported that the mean size of mature Bull Trout in a selection of large lakes, reservoirs, and rivers in British Columbia ranged from 60 to 66 cm for females and from 65 to 73 cm for males. The minimum size for spawners typically exceeded 50 cm. The largest recorded Bull Trout captured, from Pend Oreille Lake, Idaho, was 100 cm long and weighed 15 kg (Goetz 1989).

Sexual dimorphism exists in Bull Trout and male fish are often larger than females (McPhail and Murray 1979; Carl et al. 1989). Spawning males often develop a pronounced hook, or kype, on the lower jaw (McPhail and Baxter 1996).

Distribution

Global

Bull trout are endemic to western Canada and the U.S. Pacific Northwest (Federal Register 1998). Historically they were found in most of the large river systems from about 41° N (i.e., McCloud River drainage in northern California and the Jarbridge River in Nevada) to about 60° N (i.e., headwaters of the Yukon River) (Federal Register 1998). Although mostly located west of the Continental Divide, Bull Trout are also found in certain headwater systems of the Saskatchewan and McKenzie river systems of Alberta and British Columbia (Federal Register 1998). In British Columbia and Washington, Bull Trout have been primarily considered to be an interior species, found mostly east of the Coast (Cascade) Mountains (McPhail and Baxter 1996). However, as the ability of fisheries biologists to discriminate between Bull Trout and Dolly Varden has improved, coastal populations have been recognized (e.g., Olympic Peninsula; lower Fraser and Squamish rivers), with some individuals even making forays into salt water (T. Down, pers. comm.). Through the years, the distribution of Bull Trout has diminished throughout its range; most of this reduction has occurred at its southern fringe.

British Columbia

In British Columbia, Bull Trout are found in practically every major mainland drainage, including those major coastal drainages which penetrate the Coast Mountains into the interior of the province (e.g., Fraser, Homathko, Klenaklini, Bella Coola, Dean, Skeena and Nass rivers). In addition, some coastal populations of Bull Trout have been recognized (e.g., Squamish River).

Drainages/locations where they do *not* occur include Vancouver Island and the Queen Charlotte Islands; the lowermost reaches of some of the major drainages penetrating the Coast Mountains; the Petitot and Hay river systems in the north-east; most of the headwaters of the Yukon River system, except for Swan Lake in the Teslin drainage; and the Alsek system on the north coast (McPhail and Carveth 1993; McPhail and Baxter 1996).

Note that, at the current time, Dolly Varden rather than Bull Trout are identified as the species present in the majority of the coastal drainages that do not penetrate into the interior of the province.

Forest regions and districts

Coast: Chilliwack, North Island (mainland portion), Squamish

Northern Interior: Fort Nelson (absent in Petitot and Hay River drainages), Fort St. James, Kalum, Mackenzie, Nadina, Peace, Prince George, Skeena Stikine (absent in Alsek drainage and all upper Yukon drainage except for Swan Lake in Teslin system), Vanderhoof

Southern Interior: Arrow Boundary (absent in Kettle River), Cascades, Central Cariboo, Chilcotin, Columbia, Headwaters, Kamloops, Kootenay Lake, Okanagan Shuswap (absent in Similkameen and Okanagan rivers), Quesnel, Rocky Mountain

Ecoprovinces and ecosections

BOP: CLH*, HAP, KIP, PEL

CEI: BUB, BUR, CAB, CAP, CCR, CHP, FRB, NAU, NEU, QUL, WCR, WCU

COM: CBR*, CPR*, CRU, EPR, KIM, MEM*, NAB, NAM*, NBR*, NWC, SBR*, SPR*

GED: FRL

NBM: CAR, EMR, HYH, KEM, LIP, MUF, NOM, SBP, SIU, STP, TEP*, THH*, TUR*, WMR

SBI: BAU, ESM, HAF, MAP, MCP, MIR, NEL, NHR, NSM, PAT, PEF, SHR, SOM, SSM

SIM: BBT, BOV, CAM, CCM, COC, CPK, EKT, ELV, EPM, FLV, FRR, MCR, NKM, NPK, QUH, SCM, SFH*, SHH, SPK, SPM, UCV, UFT

SOI: GUU, HOR*, LPR, NIB, NOH*, NTU, PAR, SCR, SHB, STU*, THB, TRU

TAP: ETP*, FNL*, MAU*, MUP

* = presence in portion of ecosection only

Broad ecosystem units

FS, IN, LL, LS, OW, RE, SP

Elevation

The occurrence of Bull Trout is strongly associated with elevational (Rieman and McIntyre 1995) and thermal (Pratt 1984) gradients in streams, and with thermal gradients in individual habitats (Bonneau and Scarnnechia 1996). There are anecdotal observations that Bull Trout do not occur, or are much less frequently observed, above certain threshold temperatures (e.g., Fraley and Shepard 1989; Rieman and McIntyre 1993; Parkinson and Haas 1996). In Washington State, on the west side of the Cascades, 94% of known spawning occurred above 210 m elevation. On the east side of the Cascades, 94% of known spawning occurred above 610 m elevation (Washington State Internet site). Note that these elevation data are mostly from the United States where higher temperatures have often limited Bull Trout distribution to headwater areas. In a study on B.C. populations, Parkinson and Haas (1996) considered temperature to be more important in determining Bull Trout distribution than other physical factors.

Life History

Diet and foraging behaviour

In general, Bull trout fry tend to stay near the substrate to avoid being swept downstream (Ford et al. 1995). Juvenile Bull Trout predominantly feed on aquatic insects and amphipods from benthic, pelagic, and littoral zones (Connor et al. 1997). Boag (1987) reported that juveniles in western Alberta preferentially feed on plecopterans, trichopterans, ephemeropterans, and coleopterans. Juveniles in the Flathead Basin in Montana feed on dipterans and ephemeropterans (Shepard et al. 1984).

The three life history strategies of Bull Trout largely influence diet and foraging behaviour. Steam-resident Bull Trout are often smaller than migratory fish. Of the migratory strategies, adfluvial (spawn in tributary streams and reside in lakes or reservoirs) populations tend to experience greater growth than fluvial (spawn in tributaries, but live in mainstem rivers) fish (Berry 1994; Ratcliff et al. 1996). The growth rate of Bull Trout rapidly increases in populations that enter rivers and lakes with plentiful fish prey (McPhail and Murray 1979). Adfluvial fish are predominantly piscivorous (Berry 1994; Connor et al. 1997; Mushens and Post 2000), which plays a large role in the more rapid growth rate of adfluvial fish over fluvial or resident populations.

Reproduction

Bull trout often reach sexual maturity at 5–7 years of age, but the range is 3–8 years (McPhail and Murray 1979; Fraley and Shepard 1989; Rieman and McIntyre 1996). The body size of mature Bull Trout varies according to their life history strategy (Post and Johnston 2002). Fecundity of females is proportional to body size; small, resident females may produce 500 eggs, while the much larger migratory fish will produce 2000–5000 eggs (McPhail and Murray 1979; Berry 1994).

Bull trout spawn between mid-August and late October (McPhail and Murray 1979; Rieman and McIntyre 1996). Pollard and Down (2001) noted that spawning windows for northern Bull Trout populations were generally earlier than for southern populations and may be affected by annual climatic conditions. Distance covered during spawning migrations and timing of migration varies and depends upon life history strategy (Post and Johnston 2002). Resident populations tend to migrate short distances to spawning grounds, while migratory populations may travel up to or over 250 km (McLeod and Clayton 1997; Burrows et al. 2001). McPhail and Murray (1979) and Weaver and White (1985) reported that 9°C appears to be the temperature threshold below which Bull Trout begin their spawning activities.

Females select redd sites and excavate the nest. Courtship and spawning are carried out at the redd and a complete round of spawning requires several days to complete (McPhail and Baxter 1996).

Site fidelity

Approximately 50% of radio-tagged Bull Trout in a study by Carson (2001) exhibited signs of spawning migration and post-spawning homing behaviour. The results of Carson's study suggest that Bull Trout in the McLeod system in west-central Alberta occupy a small home range and exhibit strong fidelity to their range. Swanberg (1997) also reported strong post-spawning homing behaviour suggesting some degree of site fidelity. Burrows et al. (2001) reported mixed fidelity to summer and fall habitat for feeding and spawning in the Halfway River system in north-eastern British Columbia; some radio-tagged Bull Trout had returned to locations where they had been previously located, but other fish remained in streams where they had not been previously observed.

The homing ability of Bull Trout appears to be variable and is perhaps an adaptive trait that is subject to natural selection (McPhail and Baxter 1996). McPhail and Baxter (1996) speculate that the degree of homing may be related to stream size and stability. Baxter (1995) reported that different females will select previously used redd locations in different years suggesting some degree of spawning site fidelity.

Home range

Bull Trout home range is highly variable depending upon life history strategy. The home range for resident populations is much smaller than that of migratory fluvial or adfluvial populations, which can have very large home ranges, usually because resident populations are restricted to stream reaches located above barriers to migration. Burrows et al. (2001) reported annual movement of up to 275 km in the Halfway River system. Carson (2001) reported small, discrete home ranges for Bull Trout tracked in the McLeod River system in Alberta.

Movements and dispersal

Bull Trout populations may move long or short distances to and from feeding, spawning, and overwintering sites depending upon their life history strategy. Timing of the spawning migration depends on a number of variables that include water temperature, habitat, genetic stock, and possibly daylight (photoperiod regulates endocrine control of these types of behaviour in other salmonids) (Ford et al. 1995). Mature fish from fluvial populations make spawning migrations from large to smaller rivers in mid- to late summer when the water temperatures are relatively high and water levels are typically declining (Oliver 1979; Fraley and Shepard 1989; Hagen and Baxter 1992). Many of the juvenile fish from fluvial populations migrate from their natal areas during their third summer, but some do not emigrate until their fourth summer (Oliver 1979; Pratt 1992; Sexauer 1994). Juvenile migrations begin in spring and continue through summer months (Oliver 1979).

Fluvial forms in the Peace River system make long distance migrations to and from spawning locations (Pattenden 1992; McPhail and Baxter 1996; Burrows et al. 2001), as do populations in the Columbia River system (O'Brien 1996). Adfluvial populations exhibit similar migratory patterns as the fluvial form where mature Bull Trout migrate from lakes to spawning streams (McPhail and Murray 1979; Fraley and Shepard 1989). Juvenile fish (fry, 1+, 2+, and 3+) emigrate from natal streams to lakes or reservoirs through summer months (McPhail and Murray 1979).

Habitat

Structural stage

Forest health and the maintenance of riparian forests are very important in maintaining the integrity of fish habitat. In addition, the forest structural stage surrounding streams may also play an important role. Generally, mature structural stages (5–7) produce more large woody debris than younger seral stages (Robison and Beschta 1990); more sediment trapping and storage (Bragg et al. 2000); more nutrient cycling (Bilby and Likens 1980); and more fish habitat structure (Bragg et al. 2000).

Important habitats and habitat features

Bull Trout are cold water specialists which Rieman and McIntyre (1993) identified as having more specific habitat requirements than other salmonids. These authors reviewed five habitat features that consistently influence Bull Trout distribution and abundance: channel and hydraulic stability; substrate; cover; temperature; and the presence of migration corridors. The influence and temporal importance of each of these features can be modified depending on the life history strategy (fluvial, adfluvial, or resident) and life history stage.

Spawning

Bull Trout spawn in flowing water (references cited in McPhail and Baxter 1996) and show a preference for gravel and cobble sections in smaller, lower order rivers and streams. Bull Trout tend to be very selective when choosing spawning locations. Spawning sites are characterized by low gradients (~1.0–1.5%); clean gravel <20 mm; water velocities of 0.03–0.80 m/s; and cover in the form of undercut banks, debris jams, pools, and overhanging vegetation (references cited in McPhail and Baxter 1996).

Water temperature plays an important role in Bull Trout spawning success. A threshold temperature of 9°C has been suggested as the temperature below which spawning is initiated (McPhail and Murray 1979; Weaver and White 1985), at least for more southern stream systems. More recent data on temperature/spawning timing in northern B.C. systems suggest that temperature thresholds are lower or that temperature is not as important a cue because mean stream temperatures at spawning locations rarely exceed 9° at any time of the year (T. Zimmerman, pers. comm.).

The stability of the temperature environment in natal streams is likely a much more critical feature of high quality spawning locations. There may also be a lower temperature threshold below which spawning is suspended. Allan (1987) reported that Bull Trout in Line Creek in the east Kootenay region of British Columbia stopped spawning when water temperatures dropped below 5°C. Egg incubation requires temperatures <8°C and an optimal range of 2–4°C (Berry 1994; Fairless et al. 1994).

Groundwater interaction with surface water likely creates thermal stability at spawning sites that can act to minimize winter hazards for incubating eggs (Baxter and McPhail 1999). During the winter, stream temperatures in parts of British Columbia are at or very near 0°C; therefore, anchor ice formation is a constant threat to incubating eggs. A stable winter environment would be a spawning site that (1) could be predicted to be anchor ice free for most winters, or (2) demonstrates a stable thermal signature above 0°C year over year (T. Zimmerman, pers. comm.).

Rearing and foraging

In general, all Bull Trout (regardless of the life stage or life history strategy) are cold water specialists. Bull Trout are seldom found in systems where water temperature is above 15°C for prolonged periods (references cited in McPhail and Baxter 1996). Adults are primarily piscivorous and depend on an adequate forage base to support growth and reproduction. Bull Trout appear to be primarily ambush predators and are highly dependent on cover, usually in the form of deep pools, woody debris jams and undercut banks (T. Down, pers. comm.).

Bull Trout fry are often associated with shallow water, low-velocity side channels, and abundant instream cover in the form of cobble and boulders (Environmental Management Associates 1993; Baxter 1994, 1995). Bull Trout fry focus their feeding on aquatic insects near or on the bottom of the stream (Nakano et al. 1992).

Most juveniles rear in streams and appear to prefer pools over riffles, runs, or pocket water (Fraley and Shepard 1989; Nakano et al. 1992). Adequate instream cover is an important component of juvenile habitat. Juveniles in Line Creek in the east Kootenay region of southeastern British Columbia were associated with large woody debris (LWD), undercut banks, and coarse substrate (Allan 1987). Juveniles are benthic and drift foragers (Nakano et al. 1992) that feed on aquatic insects until the fish reach about 11 cm, at which time they usually switch to preying on other fish (Pratt 1992).

Overwintering

Juvenile overwintering in streams is more closely associated with cover than during summer months (Sexauer 1994). Overhead cover, deep, low-velocity water, and the absence of anchor ice are important overwintering habitat features for juveniles (Thurow 1997).

Stream-resident populations of Bull Trout, particularly those in northern latitudes, require suitable ice-free overwintering sites and this is a critical component in maintaining viable populations (McPhail and Baxter 1996). In the fall, fish will move from small tributaries into larger streams or rivers (Craig and Bruce 1982; Stewart et al. 1982). In the Sukunka River in northeastern British Columbia, Bull Trout overwinter in deep pools (Stuart and Chislett 1979). As for juveniles, adult overwintering habitat requirements are low velocity water with sufficient depth to provide ice-free refuges and overhead and instream cover (Rhude and Rhem 1995). Adults often undergo extensive downstream migrations to overwintering habitat (e.g., Burrows et al. 2001).

Conservation and Management

Status

The Bull Trout is on the provincial *Blue List* in British Columbia. Its status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	ID	AK	MT	OR	WA	YK	Canada	Global
S3	S3	S3	S?	S3	S3	S3	S?	N3	G3

Trends

Population trends

Generally, Bull Trout populations are considered to be declining in abundance throughout their native range in Canada and the United States (references cited in Post and Johnston 2002). For the most part, this range reduction is comprised of localized extinctions, although in at least one system (the McCloud in California) they no longer exist (McPhail and Baxter 1996). In Alberta, Bull Trout populations have been in decline since the beginning of the 1900s.

In British Columbia, the general trend for Bull Trout populations is stable to diminishing (Pollard and Down 2001) – stable if adequate protection measures are implemented and enforced, but diminishing if forest practices and road development activities (including petroleum development roads in northeastern British Columbia) continue to degrade and exclude suitable Bull Trout habitat. Population trends for Bull Trout in British Columbia are shown in Figure 1 (note that there are minor inconsistencies between the Bull Trout distributions shown in Figure 1 and the Bull Trout distributions noted earlier in this account).

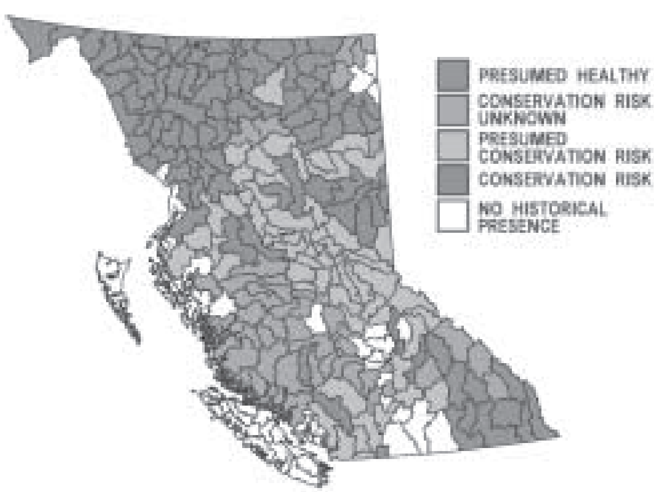


Figure 1. Status of Bull Trout in British Columbia by watershed group. Conservation risk means that the population is known to be in decline (B.C. MWLAP 2002).

Habitat trends

Given the broad distribution of Bull Trout in British Columbia, no studies have attempted to quantify trends in Bull Trout habitat across the provincial landscape. In this situation, it is appropriate to use indicators of general habitat condition; one such indicator is road density in watershed groups (B.C. MWLAP 2002), with road density being a surrogate measure of the amount of development in a given watershed. Cross and Everest (1997) examined the link between changes in habitat attributes for Bull Trout in "managed" watersheds (roaded and subject to logging and/or mining activity) and unroaded/unlogged watersheds. They noted, among other findings, a reduction in pool depth and volume in managed watersheds, which were considered to be key impacts to Bull Trout habitat. In British Columbia, road length increased by 45% between 1988 and 1999 (B.C. MWLAP 2002). This finding suggests a general decline in the quality of Bull Trout habitat in British Columbia.

Threats

Population threats

In British Columbia, a primary threat to Bull Trout is the fragmentation of populations through the disruption of migration patterns. Except for populations upstream of migration barriers, subpopulations that occur in the same watershed most likely exchange genetic material and are able to recolonize streams following catastrophic events. Studies on these clusters of subpopulations or "metapopulations" indicate that the likelihood of persistence decreases as local populations become isolated from each other through the creation of barriers to migration. Obstructions to Bull Trout movement can be fairly obvious (e.g., perched culvert outlets or water velocity through a culvert) or more subtle, such as sections of degraded habitat (e.g., stream channel instability, increasing water temperatures, sedimentation of substrate, or lack of cover). Once fragmented, the components of a metapopulation are much more prone to extirpation from both stochastic and deterministic risks.

A second primary threat to Bull Trout is their sensitivity to angling pressure. The significant increase in the number of roads, and other linear developments such as seismic trails, pipelines, and power line corridors, in previously unroaded watersheds, especially in northeastern British Columbia, is a major concern for Bull Trout populations because it allows anglers and poachers unprecedented access to streams that were previously protected by their remoteness. Poaching and non-compliance with conservative regulations for Bull Trout is a serious problem in previously more remote regions of the province.

Other threats to Bull Trout populations include disease and competition with other species.

Habitat threats

Of all the salmonid species, Bull Trout have the most specific habitat requirements (Rieman and McIntyre 1993) and are very sensitive to habitat degradation. Their specialization as a cold water species makes them highly susceptible to activities such as riparian timber harvesting. Loss of stream shading can lead to elevated water temperatures (both daily mean and peak temperatures), which can be problematic for a species that is seldom found in streams or lakes where temperatures rise above 15°C. Increasing water temperatures can lead to population fragmentation and increase the risk of invasion by other species that may displace Bull Trout and lead to further decreases in their abundance (Parkinson and Haas 1996).

Bull Trout require clean, well-oxygenated water; as a result, the distribution and abundance of all Bull Trout are strongly influenced by channel and hydrologic stability. The eggs and young of this fall-spawning species are vulnerable to winter and early spring conditions such as low flows, which can strand eggs and embryos or lead to freezing within the substrate. These life stages are also susceptible to flooding and scouring. Success of embryo survival, fry emergence, and overwinter survival of juveniles is related to low sedimentation levels, because increased sediment leads to losses in pool depth and frequency; reductions in interstitial spaces; channel braiding; and potential instabilities in the supply and temperature of groundwater inputs (Rieman and McIntyre 1993).

Forest harvesting, petroleum and mining development, and associated access; livestock grazing; and urban development are all anthropogenic threats to the integrity of Bull Trout habitat. The effects of these threats can be separated into three general categories: (1) elimination of habitat or restriction of fish access; (2) sedimentation and erosion; and (3) alteration or loss of required habitat characteristics.

Elimination or restriction

Pre-Forest Practices Code forest harvesting and forestry road development, and petroleum exploration and development access construction, have contributed to the decline in Bull Trout populations around the province by disrupting migration corridors. Perched culverts, debris, channelization, increased water temperatures, and increased water velocities are all capable of influencing access to important habitats utilized by adfluvial, fluvial, and resident Bull Trout populations. Construction of dams and reservoirs in the Peace River and Columbia River watersheds eliminated significant amounts of stream habitat through inundation and also created barriers that, in some cases, have altered historical migration patterns. The resultant isolation and restriction of populations related to these access barriers may reduce the gene flow within and between populations and negatively affect the long-term success of distinct Bull Trout populations throughout the province.

Sedimentation and erosion

Significant changes in unit area peak flows, unit area storm volumes, and response time to storm events are known to be associated with increased development within a watershed (e.g., forest harvest; grazing; petroleum resource, mining, and urban development). As the area of a clearcut increases, a corresponding increase in storm volume occurs. Road development leads to earlier, higher peak flows and can also alter groundwater flows. In addition to influencing peak flows, roads may act as sediment sources.

An increase in sediments and erosion (above natural background levels) are undesirable as they can degrade spawning and rearing habitat, and cause direct injury to fish, by:

- infilling gravel spawning substrate;
- infilling pool and riffle habitat;
- impairing feeding ability, through increased turbidity;
- reducing food availability for juvenile fish and lowering stream productivity, through smothering of aquatic insects; and
- clogging and abrading of fish gills.

Alteration of habitat characteristics

The presence of riparian vegetation is a critical factor in the maintenance of many important habitat features required by Bull Trout and other fish species. However, riparian vegetation is frequently removed as a result of development activities within a watershed, and this loss has significant negative impacts on fish habitat. Riparian vegetation:

- Provides a source of short- and long-term LWD recruitment, which is a key component in the creation of optimal salmonid habitat such as pools and cover (Chilibeck et al. 1992);
- Maintains lower water temperatures by shading the channel—a critical habitat factor for Bull Trout (Scruton et al. 1998; Maloney et al. 1999);
- Increases bank stability and maintains integrity of channel morphology (Robison and Beschta 1990; Chilibeck et al. 1992; Bragg et al. 2000);
- Provides a substrate for many terrestrial insects, which are in turn an important aquatic food source, and provides organic matter (in the form of leaf litter) that supports the aquatic food chain (Chilibeck et al. 1992; Wipfli 1997); and
- Acts as a buffer zone to intercept runoff and filter for sediment and pollutants (Chilibeck et al. 1992).

As for other fish and aquatic organisms, climate change and associated global warming are predicted to reduce Bull Trout habitat by leading to increased water temperatures and leaving even more areas unsuitable for all life stages of this cold water specialist (Kelehar and Rahel 1992; Mullan et al. 1992).

Legal Protection and Habitat Conservation

Bull Trout in British Columbia are protected under the provincial *Wildlife Act*, the provincial *Fish Protection Act*, and the federal *Fisheries Act*. The *Wildlife Act* enables provincial authorities to license anglers and angling guides, and to supply scientific fish collection permits, and the *Fish Protection Act* provides the legislative authority for water managers to consider impacts on fish and fish habitats before approving new water licences or amendments to existing licences, or issuing approvals for works in and about streams. However, the *Fish Protection Act* cannot be used to supercede activities authorized under the provincial *Forest Act*, or where the Forest Practices Code or its successor, the *Forest and Range Practices Act*, applies (see Section 7(7), *Fish Protection Act*).

The federal *Fisheries Act* delegates authority to the Province to establish and enforce fishing regulations under the British Columbia Sport Fishing Regulations. These Regulations incorporate a variety of measures to protect fish stocks, including stream and lake closures, catch and release fisheries, size and catch limits, and gear restrictions.

In addition, Section 35(1) of the federal *Fisheries Act* prohibits activities that may result "in the harmful alteration, disruption, or destruction of fish habitat." Similarly, Section 36(3) of the Act prohibits the deposition of a "deleterious substance of any type" into waters frequented by fish.

Also of note is the fish habitat policy of the federal Department of Fisheries and Oceans, which includes a goal of "… no net loss of the productive capacity of fish habitat", which is designed to maintain the maximum natural fisheries capacity of streams (Chilibeck et al. 1992).

The provincial system of parks and protected areas, and the federal system of parks, provide some level of protection for certain populations, or portions of populations, of Bull Trout. However, given the wide distribution of this species, most of its habitat in British Columbia does not lie within the boundaries of a protected area.

Provisions enabled under the Forest Practices Code (FPC) or its successor, the *Forest and Range Practices Act* (FRPA), that may help maintain habitat for this species include: ungulate winter range areas; old growth management areas; riparian management areas; community watersheds; coarse woody debris retention, visual quality objectives; and the wildlife habitat feature designation. All of these, except community watersheds, have the ability to protect relatively small portions of streamside vegetation (i.e., a few hundred hectares) along a stream; community watersheds have the potential to protect an entire population of a stream resident form.

However, for Bull Trout, these provision are considered to be coarse filters only and thus inadequate to conserve Bull Trout, as this species is more sensitive to habitat disturbances than most other fish species. For example, one potential problem with these provisions is that the current Riparian Management Area (RMA) guidelines do not require retention of a reserve zone on S4 streams (small, fish-bearing; <1.5 m wide), only a 30 m management zone (MOF and MOELP 1995). Given Bull Trout's preference for cool water systems and their use of smaller headwater systems, these guidelines may be inconsistent with the goal of protecting Bull Trout critical habitat.

Provisions exist within FRPA to allow watersheds to be designated as having significant fisheries values, and streams to be designated as being temperature sensitive. The former designation could lead to requirements to consider cumulative hydrologic impacts, while the latter could have implications with regard to riparian retention on S4 and S5 streams. However, notwithstanding that significant fisheries watersheds are as yet undefined, both provisions will require a proactive designation by MWLAP before the provisions would be available to protect and conserve Bull Trout habitat.

The data necessary for such value judgments by the Ministry is not widely available. Furthermore, the impact to the overall temperature regime of individual watersheds, and thus on any downstream fisheries values, as a result of logging small headwater tributaries to their stream banks is poorly understood.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Due to the wide distribution of Bull Trout in the province, the varying migratory patterns of the species, and the species' use of a variety of sparsely distributed habitats, wildlife habitat areas (WHAs) cannot address all aspects of the Bull Trout's life history requirements. In addition, as this species is especially sensitive to habitat degradation, its requirements must be addressed at the landscape level, in order to effectively manage for the maintenance of populations.

In sub-basins where Bull Trout are present, and where forest development is planned for the next 5-year period, any of the following are recommended as supplementary triggers for the watershed assessment procedure (WAP):

- more than 10% of the watershed has been logged in the 20 years prior to the start of the proposed development plan, or will be logged in the 25 years prior to the end of the proposed development plan;
- a "significant" number of mass-wasting events are known to have occurred in the watershed (i.e., more than one event/km^2 and more than two events reaching the mainstem);
- the presence in the watershed of either high stream channel density (i.e., more than 1 km of channel/km^2), high road density (i.e., more than 150 m of road length/km^2), or a siginificant number of stream crossings (i.e., more than 0.6/km^2 in the interior or more than 1.4 km^2 on the coast); or
- evidence of significant stream channel stability problems.

The objective of the WAP is to avoid cumulative hydrologic impacts that may affect channel stability or structure. If the WAP determines that the watershed is sensitive to disturbance (a rating of Medium or High in the Hazard Category), Bull Trout populations are at risk. In such sensitive watersheds, the following conservation measures, based on the metapopulation concept, should be demonstrated by strategic and operational planning processes, and reflected in the temporal and spatial layout of cutblocks, road layout and design, and hydrologic green-up and recovery standards:

- Minimization of upstream and upslope disturbances to prevent siltation, temperature, and hydrologic impacts (including disruptions of groundwater flows) in areas influencing critical reaches of Bull Trout habitat;
- Minimization of road networks, total road length, and number of stream crossings, and avoidance of linear road developments adjacent to stream channels, where practical from an engineering perspective;
- Maintenance of riparian habitats in a properly functioning condition, to ensure LWD recruitment is based on life expectancy and decay periods of naturally occurring adjacent tree species;
- Minimization of obstructions to movements, and isolation of populations (e.g., ensure stream crossings will pass migrating Bull Trout at all flows and life history stages, etc.);
- Minimize road construction within 0.5 km of known Bull Trout congregations; and
- Maintain riparian reserves on S4 streams with or suspected to have Bull Trout, or S5 and S6 streams that are tributary to streams with Bull Trout, where local managers deem necessary to protect natural stream processes and limit erosion and sedimentation.

General wildlife measures

Apply general wildlife measure to "identified fisheries sensitive watersheds," as defined by MWLAP, where Bull Trout were part of the rationale for the designation *or* at and above S4 streams with Bull Trout congregations. A congregation is defined as a significant portion of a run. A significant portion will generally be >20% of the adult population of a run, depending on professional judgement. True congregations will be intuitively obvious at critical times of the year. They should be based on a ground survey or aerial redd count that identifies a significant portion of the run accumulating at a specific location/habitat that will be reasonably stable over several years.

Goals

1. Prevent or minimize access to Bull Trout congregations.
2. Prevent or minimize detrimental alterations to Bull Trout habitat, including sedimentation.
3. Maintain important habitat features including cover, substrate quality, pool depth and volume, groundwater flow, water quality, temperature, channel structure, and hydrologic characteristics of the site.
4. Ensure large woody debris recruitment based on life expectancy and decay periods of naturally occurring adjacent tree species.
5. Maintain migration corridors and prevent isolation of Bull Trout population.
6. Maintain or rehabilitate to a properly functioning condition.

Measures

Access

- Do not construct roads and excavated or bladed trails. Where there is no alternative to road or trail development, close to public during staging and spawning times and rehabilitate as soon as possible. Ensure that roads do not impact stream channel integrity, water quality, groundwater flow, substrate composition, cover, and natural temperature regimes.
- Avoid stream crossings at Bull Trout concentrations. Stream crossings should be built to the highest standards to minimize the risk of sediment input or impacts to the channel.

Harvesting and silviculture

- Plan harvest to meet goals of maintaining stream channel integrity, water quality, groundwater flow, and substrate composition; and to minimizing disturbance.

Range

- Do not place livestock attractants within 500 m of known congregations.

Recreation

- Do not develop recreational trails, facilities, or structures within 500 m of known congregations.

Additional Management Considerations

Place roads as far as practicable from critical Bull Trout habitat.

Avoid development of recreational trails, facilities, or structures immediately adjacent to WHAs.

Information Needs

1. Biology, ecology, and limiting factors of the anadromous form of Bull Trout in British Columbia (e.g., factors limiting juvenile recruitment, juvenile migratory patterns and habitat use, dispersal mechanisms, and rates).
2. Knowledge of distribution and stock status is inadequate in most areas of the province.
3. Effects of sustained forest harvesting on the quality and quantity of groundwater supplies in Bull Trout watersheds.

Cross References

Grizzly Bear, "Westslope" Cutthroat Trout

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"Westslope" Cutthroat Trout

Oncorhynchus clarki lewisi

Original prepared by Stephen Bennett

Species Information

Taxonomy

The Westslope Cutthroat Trout is one of 14 subspecies of interior Cutthroat Trout, *Oncorhynchus clarki,* native to western North America (Behnke 1992). Westslope Cutthroat Trout were first described by the Lewis and Clark expedition in the Missouri River, near the present-day city of Great Falls, Montana in 1805 (Behnke 1992). However, as recently as the 1970s, there was confusion regarding the appropriate taxonomic classification of the Westslope Cutthroat Trout (Roscoe 1974). Today, Westslope Cutthroat Trout are considered a distinct taxonomic form, distinguishable from the Yellowstone (*O. clarki bouvieri*) and other subspecies of cutthroat trout on the basis of spotting pattern, karyotype (66 chromosomes), and biochemical characteristics (Behnke 1992). The subspecies *O. clarki alpestris*, known as the "Mountain" Cutthroat Trout, is considered a synonym of Westslope Cutthroat Trout; it occurs as disjunct stocks ranging from eastern Oregon into British Columbia (Trotter 1987; Behnke 1992).

Westslope Cutthroat Trout live in a variety of different stream conditions, from heavily glacial systems to clear, stable, spring-fed streams, and many populations are isolated from one another by natural barriers and watershed divisions. As a result, there are many distinct forms in British Columbia and they exhibit a high degree of within-species diversity.

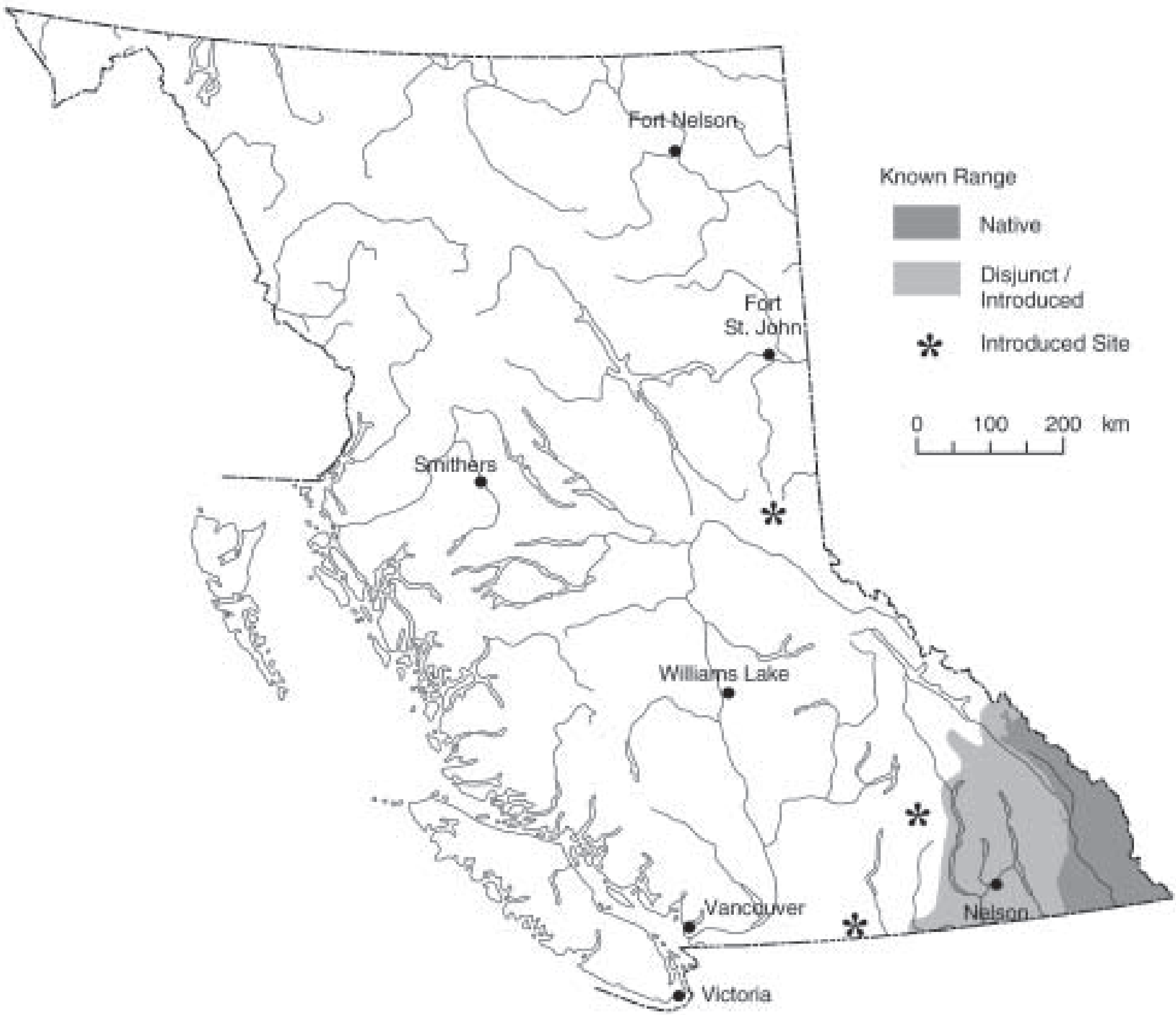
The present distribution of interior Cutthroat Trout was determined approximately 70 000 years ago by the formation of barrier falls on the Kootenay, Clark Fork, Pend Oreille, and Spokane rivers (Behnke 1992). Westslope Cutthroat Trout were able to colonize above what are now major barrier falls because water levels were higher during the glacial retreat and/or barriers formed following glacial retreat as the land mass rebounded. Westslope Cutthroat Trout were isolated above these barrier falls and survived in refuge areas in Montana, Idaho, and Washington during the last ice age. Rainbow Trout (*Oncorhynchus mykiss*) appear to have been restricted to the lower Columbia River during this period and did not occur above the barrier falls allowing Westslope Cutthroat Trout to colonize inland portions of North America in isolation from Rainbow Trout (Behnke 1992). Westslope Cutthroat Trout were also able to move between some drainage systems likely through headwater transfers. These events are critical in understanding cutthroat conservation as Westslope Cutthroat Trout evolved independent from Rainbow Trout and lack innate isolating mechanisms that allow them to co-exist (Behnke 1992).

Description

Cutthroat Trout get their common name from a distinctive red slash that occurs just below both sides of the lower jaw. Westslope Cutthroat Trout have small irregular-shaped spots along their back, dorsal, and caudal fins. Few spots occur below the lateral line on the anterior of the body. Adults typically exhibit bright yellow, orange, and/or red colours along the ventral area, especially among males during the spawning season. Typically they are silver with yellow, green, blue, or brown hints on the back; however, overall body colour can vary widely and reflects the colour of the substrate and water. Fish in turbid and/or glacial fed streams with moderate to high gradients (e.g., Akolkolex River) tend to be paler and have fewer but larger spots with narrow body profiles, while fish in clear streams with low gradients (e.g., St. Mary River) have heavier smaller spotting and rounder body profiles.

Westslope Cutthroat Trout

(Oncorhynchus clarki lewisi)



Note: This map is based on current knowledge of species' distribution. Distinct populations also occur in scattered locations through the Southern Interior. This species may or may not occur in all areas indicated.

Distinguishing characteristics include the presence of basibranchial teeth (Rainbow Trout lack these) and the upper jaw extends back past the hind margin of the eye (McPhail and Carveth 1992). Westslope Cutthroat Trout adults rarely exceed an overall length of 500 mm in lake- or stream-dwelling populations (Shepard et al. 1984; Westslope Fisheries 2003; J. Baxter, pers. comm.). For example females were found to be larger and weigh more than males in the Elk and Wigwam rivers (adult females = 396 mm [375–421 ± 1.5], 933 g [800–1100 ± 116.9]; adult males = 371 mm [336–422 ± 2.8], 700 g [450–1200 ± 223.6]; Westslope Fisheries 2003). Similar average fish size was observed n the Wigwam River (J. Baxter, pers. comm.).

Distribution

Global

The range of Westslope Cutthroat Trout is the most geographically widespread among the 14 subspecies of interior Cutthroat Trout (Behnke 1992). The Westslope Cutthroat Trout is native to southeastern British Columbia, southwestern Alberta, western Montana, northern Idaho, and small disjunct populations occur in parts of Washington, Oregon, and Wyoming (McPhail and Carveth 1992; Mayhood 1999; USFWS 1999). The historic distribution of Westslope Cutthroat Trout is not exactly known but is thought to have occurred west of the Continental Divide in several tributaries to the Columbia River, including the upper Kootenay River, through northwest Montana, and into northern Idaho (Behnke 1992). East of the Continental Divide, the historic distribution includes the headwaters of the South Saskatchewan River drainage (United States and Canada); and the entire Missouri River drainage upstream from Fort Benton, Montana, and extending into northwest Wyoming (Behnke 1992).

British Columbia

The largest contiguous range of native Westslope Cutthroat Trout is in the upper Kootenay and Flathead River systems with disjunct populations scattered throughout the lower Kootenay, lower Columbia watersheds. The species has been widely introduced in small headwater lakes throughout the upper Columbia and Arrow Lakes region of the lower Columbia watershed and the upper and lower Kootenay river systems. Other scattered introductions have occurred in the Kettle River system, the upper Shuswap river system and the upper Murray River system (Peace drainage) (G. Norris, pers. comm.) Other unconfirmed introductions have likely occurred (McPhail and Carveth 1992). McPhail and Carveth 1993 indicate that Westslope Cutthroat Trout have been introduced into the Similkameen drainage (page 66), but that "natural populations are absent…" (page 77).

Forest regions and districts

Northern Interior: Peace (introduced population in Murray River)

Southern Interior: Arrow Boundary (scattered/introduced), Columbia (isolated/introduced), Kootenay Lake (scattered/introduced), Okanagan Shuswap (isolated/introduced), Rocky Mountain (native/introduced)

Ecoprovinces and ecosections

SBI: SHR (introduced)

SIM: BBT, CCM, COC, CPK, EKT, ELV, EPM, FLV, MCR, NKM, SCM, SFH, SHH, SPK, SPM, UCV

SOI: OKR (introduced)

Biogeoclimatic units

AT, BG, ESSF, ICH, IDF, MS

Broad ecosystem units

FS, IN, LL, LS, OW, SP, WL

Elevation

450–2300 m

Life History

Diet and foraging behaviour

Like most trout, the Westslope Cutthroat Trout are an opportunistic forager and, without competition from other trout species, they feed on the most abundant food sources available. In general, they feed on aquatic and terrestrial macroinvertebrates such as chironomids, caddisflies, mayflies, stoneflies, water boatmen (Corixidae), ants, and grasshoppers (Alger and Donald 1984; Liknes and Graham 1988; Moore and Gregory 1988b). In lakes, zooplankton also make up an important component of their diet (Liknes and Graham 1988). Other fish and even small mammals can be preyed upon opportunistically.

When feeding in streams Westslope Cutthroat Trout usually depend on drifting aquatic insect larvae. They often feed most at dawn and dusk which corresponds to an increased density of downstream invertebrate drift. Adult fish tend to occupy the best habitat such as deep pools and runs where there is abundant cover and low to moderate gradients. Griffith (1972) found that the age of Westslope Cutthroat Trout was positively correlated to the depth of water they occupied. Juvenile fish are usually forced to feed in less optimal habitat such as shallow riffles and glides.

Reproduction

Westslope Cutthroat Trout typically reach maturity at different ages depending on local conditions and genetic stock. Age at sexual maturity has been reported from 2 to 6 years (Brown 1971; Lukens 1978; Liknes and Graham 1988; Behnke 1992). Males tend to mature a year sooner than females (Behnke 1992). Downs et al. (1997) reported length was a better predictor of maturity than age which suggests that in streams with higher growth rates, fish mature earlier. Adults begin to display spawning colours in March and April and disperse to spawning streams in May and June. Spawning can occur from April through August but tends to peak in late May through to mid-June (Ford et al. 1995; Henderson et al. 2000; Corbett 2001). Populations in headwater streams spawn later, usually peaking in mid July (Northcote and Hartman 1988). They may repeat spawning in successive years depending on local conditions and repeat spawners can be upwards of 70% of the spawning population (Liknes and Graham 1988).

Spawning redds are constructed by the female who is attended by one or more males. Once the eggs are fertilized they are covered by the female and the redd is not protected by the adults. The eggs incubate in the gravel for 6–7 weeks. They spend an additional 1–2 weeks in the interstitial space in the gravel before the fry emerge from the gravel usually peaking in mid-July through early August (Griffith 1972; Northcote and Hartman 1988). The fry then either migrate to other habitat or rear in their natal stream.

Site fidelity

Site fidelity is poorly understood for most British Columbia populations. It is generally accepted that most adults return to the natal stream to spawn and then return to a relatively small home range area in either a large stream or lake for the remainder of the year (Behnke 1992). However, there appears to be a wide variety of site fidelity strategies between disjunct populations and some times within individuals of the same population. A tagged male and female that entered a spawning tributary at the same time returned to the same mainstem location they were captured in and overwintered there (Westslope Fisheries 2003; A. Prince, pers. comm.). However, repeat spawners in the Blackfoot River spawned >3 km from the previous spawning site and showed no fidelity to pre-spawning mainstem location (Schmetterling 2001). Water flows were different between years during the Blackfoot study which may have influenced spawning site selection; however, the author suspected that the abundance of spawning habitat available may have been a more significant factor on spawning site selection.

Home range

Home range size is highly variable and dependent on life style (i.e., adfluvial, fluvial, or resident). In general, resident fish would have smaller home ranges than adfluvial or fluvial forms. Spawning migrations can exceed 150 km (Bjornn and Mallet 1964; Shepard et al. 1984). The mean home range of Elk River fish based on year 2000 radio-telemetry results was 6.19 km (range: 1.6–16.9). More recent observations on the Elk River have discovered adults moving more than 50 km upstream during the fall from summer feeding areas to wintering pools (A. Prince, pers. comm.). In the Wigwam River (a tributary to the Elk River) adults were also observed traveling large distances between spawning and wintering sites and, in one case, traveled 103 km (Baxter and Hagen 2003). Populations in high elevation streams with high gradients and numerous barriers are likely more sedentary.

Movements and dispersal

Fluvial and adfluvial forms have been recorded to move large distances (>25 km) during migrations related to spawning, feeding, or other habitat requirements (Bjornn and Mallet 1964; Shepard et al. 1984; A. Prince, pers. comm.). For example, they often move from shallow summer feeding areas to deep pools for overwintering (Brown and Mackay 1995; Westslope Fisheries 2003). Movement is also associated with water temperature with fish beginning to move to spawning areas when mean average temperatures reach 7–10°C. Adults tend to disperse in the summer after spawning and then begin to congregate in the fall beginning around October when they move in to wintering habitat (Brown and Mackay 1995; Brown 1999; Hilderbrand and Kershner 2000; Westslope Fisheries 2003). Fish remain in wintering habitat for 4–5 months and movement is usually restricted to <1 km within wintering habitat (Brown 1999; Westslope Fisheries 2003).

Westslope Cutthroat Trout may move relatively little in stream reaches that have numerous pools, whereas movement can be more extensive in stream reaches with few pools (McIntyre and Rieman 1995). There are also indications that groundwater springs may play an important role in movements. Fish may be able to overwinter in marginal habitat if groundwater springs are present (P. Davidson, pers. comm.).

Habitat

Structural stage

Generally, structural stages 5–7 produce greater amounts of large organic debris (LOD) which has an important influence on stream channel development (Robison and Beschta 1990); sediment trapping and storage (Bragg et al. 2000); nutrient cycling (Bilby and Likens 1980); and fish habitat stucture (Bragg et al. 2000).

Important habitats and habitat features

Spawning

Spawning habitat for this species varies depending on the available habitat and presence of competitors, but usually occurs in low-gradient stream reaches that have gravel substrate ranging from 2 to 75 mm in diameter, water depths near 0.2–0.40 m, and mean water velocities from 0.25 to 1.05 m/s (Shepard et al. 1984; Ford et al. 1995; Westslope Fisheries 2003). Cover near spawning habitat is important for adult fish to hold in before beginning spawning and to escape predators (Corbett 2001; Westslope Fisheries 2003).

Westslope Cutthroat Trout often spawn in small clear tributaries with low-gradients, gravel substrates, stable flows, low sediment loads, and temperatures around 7–10°C (Behnke 1992; Ford et al. 1995; McIntyre and Rieman 1995). However, 13 of 20 fish tagged in the Elk River in 2001 (65%) spawned in the main Elk River. The 2001 spring freshet was significantly lower than normal which may have influenced the selection of spawning areas. Newly deposited gravel substrate, in either tributaries or mainstems, may be critical for spawning success (Westslope Fisheries 2003). Baxter and Hagen (2003) found that mainstem habitat was used almost exclusively for spawning in the Wigwam River, and that stream margins and/or side channels were of particular importance.

Rearing and foraging

For stream resident fish optimal foraging habitat usually consists of a series of riffles and pools with excellent cover in the form of undercut banks, log jams, boulders, and/or deep pools. Depths of pools have been positively correlated to the age of fish and large adults usually occupy the deepest pools with the best cover (Griffith 1972). Young fish, in particular fry, rear and forage along the margins of streams, in off-channel habitat, and in small tributaries. Lower reaches of streams that are susceptible to warming in the summer are typically avoided or activity is curtailed as Westslope Cutthroat Trout are less tolerant than other salmonids to warm water temperatures (i.e., >20°C) (McIntyre and Rieman

1995). Recent genetics evidence suggests that some adults from the lower St Mary River move to the upper St Mary River, possibly in search of cooler temperatures (P. Corbett, pers. comm.).

Young fish use a variety of habitats depending on the life history of the population they belong to (i.e., adfluvial, fluvial, or lake resident populations). For adfluvial and fluvial populations fry often use habitat where water velocities are very low (<1 cm/s) and water depths often do not exceed 20 cm (Ford et al. 1995). Gravel and cobble substrates are also important as cover for fry (Moore and Gregory 1988a; Ford et al. 1995). Age 1+ and 2+ tend to use areas with higher velocities (maximum of 22 cm/s) and deeper water depths (Ford et al. 1995). Natural lake resident populations are rare in British Columbia although there are numerous stocked mountain lakes. Young lake resident fish rear mainly in the littoral zone.

Overwintering

Overwintering pools may contain large numbers of mature adults throughout the fall and winter (Westslope Fisheries 2003). These pools usually exist in large mainstem streams (order 4 and up) and have features that provide deep water (>2 m deep), slower water velocity, and optimal cover. Large boulders, bedrock, or large organic debris are often associated with these pools.

Staging

Prior to entering a spawning tributary in the spring adults can congregate at the mouth of spawning tributaries for several days or even weeks (Schmetterling 2001). Adults begin to display spawning colours early in the spring (February through May) and move to the mouths of tributary streams prior to spawning. Northcote and Hartman (1988) observed maturing males in April even though no spawning was observed until mid-July in small tributaries to Kootenay Lake. The habitat of staging areas has not been well defined. It likely varies depending on local conditions but generally would consist of pool habitat with good cover.

Conservation and Management

Status

The Westslope Cutthroat Trout is on the provincial *Blue List* in British Columbia. Its status in Canada has not been determined but is currently under review.

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	OR	WA	Canada	Global
S3SE	S2	S3	S3	S?	N?	G4T3

Trends

Population trends

In the United States and Alberta, populations have declined significantly from historic levels (Mayhood 1999; USFWS 1999). In the Missouri River Basin, 90% of the 144 populations known to have at least 90% genetic purity are at “high to very high” risk of becoming extinct (Shepard et al. 1997). In British Columbia, populations declined significantly in the 1960s through to the mid-1980s due to liberal fishing regulations, and increased angling pressure, access, and habitat loss (B. Westover, pers. comm.). Since implementation of more restrictive fishing regulations in the mid-1980s, populations have increased substantially (B. Westover, pers. comm.). The general trend for B.C. populations as a whole appears to be stable or increasing. However, many populations have some level of hybridization with Rainbow Trout. The number of genetically pure populations has declined in Alberta by as much as 95% from their former range (Mayhood 1999) and by as much as 97.5% in parts of their range in the United States (McIntyre and Rieman 1995). The genetic status of populations in British Columbia has not been completely determined; however, it appears that pure populations are declining (Rubidge et al. 2002; P. Corbett, pers. comm.). Genetic studies in 1987 found one tributary stream to the Kootenay River had Westslope Cutthroat

Trout/Rainbow Trout hybrids (Leary et al. 1987). A repeat sampling of the same streams in 1999 found seven streams with hybrids present (P. Corbett, pers. comm.; Rubidge et al. 2002). Current studies in British Columbia have looked at 20 streams in southeastern British Columbia and found that only five have pure populations and 15 had a moderate to high risk of becoming introgressed populations due to presence of either hybrids or naturalized Rainbow Trout populations (P. Corbett, pers. comm.).

Rainbow trout have been stocked in several lakes and streams that flow into the Kootenay River since the early 1900s. The Libby dam was completed on the Kootenay River in 1972 forming the Koocanusa Reservoir. For several years the United States attempted to establish Westslope Cutthroat in the Reservoir with little success (B. Westover, pers. comm.). Between 1986 and 1998 Gerrard Rainbow Trout were stocked in the Koocanusa Reservoir. This stocking history has no doubt been the cause of the hybridization between Westslope and Rainbow evident today. It is not known if the rate of hybridization is increasing and if populations of Westslope Cutthroat Trout in British Columbia will continue to decline as they have in Alberta and the United States; however, the genetics work conducted to date and reports from local anglers suggest that hybridization is likely increasing.

Habitat trends

Large amounts of Westslope Cutthroat Trout habitat were lost between 1960 and 1981 which coincided with a dramatic increase in the population of many East Kootenay communities. For example, Cranbrook grew from approximately 5000 to over 15 000 during this time (B. Westover, pers. comm.). With an increase in human population, a variety of development activities dramatically increased, which contributed to an incremental loss of high quality Westslope Cutthroat Trout habitat throughout much of its range. In general, lake and large stream habitat is more secure, although there continue to be some cumulative impacts from forestry, hydroelectric, mining, agriculture, urban development, and industrial pollution (Haas 1998). Tributary streams at higher elevations where forestry operations are now focusing may be at higher risk. Some habitat losses are being offset by restoration efforts (e.g., Mark Creek, Sand Creek).

Threats

Population threats

By far the biggest threat to the continued existence of Westslope Cutthroat Trout is genetic introgression with Rainbow Trout (Allendorf and Leary 1988; Taylor and Stamford 2000). Stocking of Rainbow Trout in Westslope Cutthroat Trout habitat and the subsequent naturalization of Rainbow Trout is the leading cause of introgression between the two species (McIntyre and Rieman 1995; Haas 1998). Other threats include increased access; overfishing; predation by non-native species; and competition and displacement from non-native fish. Some populations may be more susceptible to disturbance if they naturally occur over a limited range and/or in small numbers (Allendorf and Leary 1988).

The vast increase in the number of roads in previously unroaded watersheds is a major concern because it is allowing anglers unprecedented access to streams. Westslope Cutthroat Trout are particularly sensitive to angling pressure because they are readily caught even by novice anglers. Poaching can also increase if access to previously roadless areas is developed and the number of enforcement personnel is not also increased.

Haas (1998) classified Westslope Cutthroat Trout a species that requires “special forestry consideration” because they exhibit the following life history and ecological characteristics that make them susceptible to forestry and other development activities:

- often found in the headwaters and small streams,
- most populations are stream resident,
- dependent on riparian and instream cover,
- dependent on natural flow and stream hydrological features,
- require clean, well-oxygenated, unembedded gravel substrate for spawning,
- repeat spawners,
- sport species that is easily angled, and
- intolerant of high temperatures.

Habitat threats

Forest harvesting, mining, agriculture, hydroelectric development, urban development, and livestock grazing have all impacted Westslope Cutthroat habitat in the past and may continue to do so. These threats influence fish habitat in the following general categories: elimination of habitat or restriction of fish access; sedimentation and erosion; and alteration or loss of required habitat characteristics.

Elimination or restriction

The creation of dams and reservoirs in the Columbia basin has eliminated large amounts of low elevation stream reaches via complete inundation (Ford et al. 1995; McIntyre and Rieman 1995). Hydroelectric developments have also created barriers that in some cases alter historic movement patterns (Ford et al. 1995). At smaller scales forestry and urban development can also impede fish movement if proper road building practices are not followed (DFO and MOE 1992). Perched culverts, debris, channelization, and increased water velocities are a common source of barriers to adfluvial, fluvial, and resident populations preventing populations from accessing key habitats (Rieman and Apperson 1989; DFO and MOE 1992; McIntyre and Rieman 1995). The isolation and restriction of populations can compromise the gene flow within and between populations and negatively affect the long-term persistence of the species (Allendorf and Leary 1988; McIntyre and Rieman 1995). Some streams in Alberta are estimated to have fewer than 30 adults in the population which may not be a sufficient minimum viable population size (D. Mayhood, pers. comm.)

Sedimentation and erosion

Forest harvesting, grazing, mining, and urban development can all contribute to increased sedimentation and nutrient loading through the increased runoff, debris torrents, and slides (Rieman and Apperson 1989; Dunnigan et al. 1998; Huntington 1998; Oman 1998; Spencer and Schelske 1998). Increased sedimentation and erosion (above natural background levels) are undesirable as they can degrade spawning and rearing habitat and cause direct injury to fish by:

- embedding (infilling gravel substrate);
- infilling pool and riffle habitat;
- clogging and abrading fish gills;
- increasing turbidity, impairing feeding ability; and
- smothering aquatic insects, reducing food availability and lowering stream productivity (Weaver and Fraley 1991; DFO and MOE 1992; Anderson 1998; USFWS 1999).

Alteration of habitat characteristics

During forest harvesting, grazing, mining, and urban development, riparian vegetation is sometimes removed or degraded. Loss of riparian vegetation can have adverse impacts on fish habitat because it can be critical in the maintenance of many important habitat features required by Westslope Cutthroat Trout. Riparian vegetation is important as it:

1. provides short- and long-term recruitment of LOD for the creation of optimal salmonid habitat such as pools and cover (DFO and MOE 1992);
2. provides shade which cools streams significantly more than streams without riparian vegetation (Scruton et al. 1998; Maloney et al. 1999);
3. increases bank stability and maintains channel morphology (Robison and Beschta 1990; DFO and MOE 1992; Bragg et al. 1998, 2000);
4. acts as a substrate for many terrestrial insects, which in turn are an important food source, and provides organic matter (in the form of leaf litter) that supports the aquatic food chain (Minshall 1967; DFO and MOE 1992; Wipfil 1997); and
5. intercepts runoff and acts as a filter for sediment and pollutants (DFO and MOE 1992).

Global warming is also predicted to further reduce Westslope Cutthroat Trout habitat by changing water temperatures thereby reducing the amount of low elevation habitat suitable for adults (Kelehar and Rahel 1992; Mullan et al. 1992; McIntyre and Rieman 1995). Increased water temperatures will also reduce the amount of cool water habitat for rearing in the upper reaches of the watershed.

Legal Protection and Habitat Conservation

Westslope Cutthroat Trout in British Columbia are protected under the provincial *Wildlife Act*, the provincial *Fish Protection Act*, and the federal *Fisheries Act*. The *Wildlife Act* enables provincial authorities to license anglers and angling guides, and to supply scientific fish collection permits, and the *Fish Protection Act* provides the legislative authority for water managers to consider impacts on fish and fish habitats before approving new water licences or amendments to existing licences, or issuing approvals for works in and about streams. However, the *Fish Protection Act* cannot be used to supercede activities authorized under the provincial *Forest Act*, or where the Forest Practices Code or its successor, the *Forest and Range Practices Act*, applies (see Section 7(7), *Fish Protection Act*).

The federal *Fisheries Act* delegates authority to the Province to establish and enforce fishing regulations under the British Columbia Sport Fishing Regulations. These Regulations incorporate a variety of measures to protect fish stocks, including stream and lake closures, catch and release fisheries, size and catch limits, and gear restrictions (e.g., large portions of the Elk and St Mary rivers are designated "catch and release" zones for most of the fishing season).

In addition, Section 35(1) of the federal *Fisheries Act* prohibits activities that may result "in the harmful alteration, disruption, or destruction of fish habitat." Similarly, Section 36(3) of the Act prohibits the deposition of a "deleterious substance of any type" into waters frequented by fish.

Also of note is the fish habitat policy of the federal Department of Fisheries and Oceans, which includes a goal of "… no net loss of the productive capacity of fish habitat", which is designed to maintain the maximum natural fisheries capacity of streams (Chilibeck et al. 1992).

The provincial system of parks and protected areas, and the federal system of parks, provide some level of protection for certain populations, or portions of populations, of Westslope Cutthroat Trout. Streams within these protected areas include: the upper portions of the Kootenay River watershed within Kootenay National Park; tributaries to the upper and lower Kootenay River within Height of the Rockies, Elk Lakes, St Mary's Alpine, West Arm, Valhalla, and Kokanee provincial parks; and tributaries to the upper Columbia River within the Purcell Wilderness Area. However, many of these areas either have limited amounts of quality habitat and/or have been subjected to many years of fish stocking with other stocks of Westslope Cutthroat Trout, Rainbow Trout, and/or Brook Trout (*Salvelinus fontinalis*), which may have compromised the genetics of the native Westslope Cutthroat Trout populations, and/or acted as direct competitors of the native populations.

Provisions enabled under the Forest Practices Code (FPC) or its successor, the *Forest and Range Practices Act* (FRPA), that may help maintain habitat for this species include: ungulate winter range areas; old growth management areas; riparian management areas; community watersheds; coarse woody debris retention, visual quality objectives; and the wildlife habitat feature designation. All of these, except community watersheds, have the ability to protect relatively small portions of streamside vegetation (i.e., a few hundred hectares) along a stream; community watersheds have the potential to protect an entire population of a stream resident form.

However, one potential problem with these provisions is that the current Riparian Management Area (RMA) guidelines do not require retention of a reserve zone on S4 streams (small, fish-bearing; <1.5 m wide), only a 30 m management zone (MOF and MOELP 1995). This could put many of the remaining pure populations of Westslope Cutthroat Trout at risk because most pure populations are now found in smaller headwater tributary streams above natural or man-made barriers (McIntyre and Rieman 1995; Mayhood 1999; P. Corbett, pers. comm.). It has not been fully determined how important S4 streams are to resident Westslope Cutthroat Trout populations but they likely provide valuable rearing habitat for fry and possibly 1+ and 2+ age classes, and potentially provide valuable spawning habitat. Under the proper conditions (i.e., groundwater springs or upwelling areas), S4 streams may even provide some overwintering habitat.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

To date there are few medium to large streams (order 4 or higher) with confirmed pure populations of Westslope Cutthroat Trout in the Kootenay River watershed (P. Corbett, pers. comm.). These streams are important and can act as a source of native, non-hybridized Westslope Cutthroat Trout that could be used to re-establish populations where they have been extirpated. To protect native populations of Westslope Cutthroat Trout consider the following recommendations:

- ❖ Because larger streams with intact populations of Westslope Cutthroat Trout are rare throughout their range and are extremely valuable, these streams (order 4 or greater) should be recognized as sensitive streams and designated as "regionally significant."
- ❖ Because the most serious threat to the native, non-hybridized populations is the introduction of non-native species to the watershed (i.e., other strains of Westslope Cutthroat Trout or other species especially Rainbow Trout), current natural and/or human-made barriers should be maintained in the short-term until the threats from non-native invasions are further assessed.
- ❖ Local managers should determine the appropriate size of the riparian zone on all order 3 and smaller streams with pure Westslope Cutthroat Trout populations based on the potential for impacts on the stream due to development. Low elevation streams susceptible to warming in the summer and any stream with naturally unstable banks or temperature sensitive streams should have minimum riparian management reserve zone of 20 m.
- ❖ Limit access to undisturbed Westslope Cutthroat Trout populations. Westslope Cutthroat Trout are susceptible to overfishing; therefore, future road building in sub-basins with Westslope Cutthroat Trout populations should be located in upslope positions to avoid providing easy access for fishing. Maintenance of restrictive fishing regulations will help to limit some impacts from the extensive existing access. Consider the following access management recommendations:
  - When planning new road development keep roads ≥1 km from mainstem streams (order 4 and greater).
  - In previously developed drainages, assess the percentage of the streamside paralleled by roads and the number of access points provided by crossings, spur roads, etc.
  - If <25% of the mainstem stream is >1 km beyond a known access point, consider removing some access points.
- ❖ Maximize connectivity of native, non-hybridized populations. Movement of individuals (gene flow) between subpopulations in the same watershed may be an important way for populations to rebound after natural catastrophic events and limiting this movement could decrease the likelihood of local populations persisting over time (Hilderbrand and Kershner 2000; Schmetterling 2001). Therefore, obstructions should not be created by in-stream structures such as culverts and bridges, and construction of dams and weirs should be strongly discouraged in Westslope Cutthroat Trout habitat.
- ❖ Limit competition from non-native species that can often displace Westslope Cutthroat Trout from preferred habitat.
- ❖ In sub-basins where Westslope Cutthroat Trout spawning or rearing are known to occur or where they likely occur and forest activities are planned in the next 5 years, any of the following criteria are recommended as supplementary triggers for the watershed assessment procedure (WAP):
  - more than 10% of the watershed has been logged in the 20 years prior to the start of the proposed development plan, or will be logged in the 25 years prior to the end of the proposed development plan.
  - sub-basins where a significant number of mass wasting events have occurred (i.e., more than one landslide/km^2 and more than two events reaching the mainstem);
  - sub-basins where there is either high road density (i.e., >150 m of road/km^2) or high stream density (i.e., >1 km of channel/km^2) or a significant number of stream crossings (i.e., >0.6/km^2); and
  - evidence of significant stream channel stability problems.

If the WAP determines that the watershed is sensitive to disturbance (i.e., a rating of medium or high in the hazard category), Westslope Cutthroat Trout populations are at risk, in which case, the temporal and spatial layout of cutblocks, hydrologic green-up, and recovery standards, and road layout and design must be considered.

❖ Recent genetic studies have shown that there is a large degree of genetic divergence between populations throughout their range (Taylor et al. 2003). In particular, populations above and streams in close proximity can have genetically unique populations. These studies suggest that multiple populations within a region need to be conserved to maintain the full spectrum of cutthroat genetic resources.

Wildlife habitat area

Goal

Maintain overwintering, staging, spawning, and rearing habitat of native, non-hybridized populations not addressed through strategic or landscape level planning. WHAs should be established across the landscape to best protect a variety of subpopulations and life stages with particular emphasis on those populations with the least risk of genetic introgression.

Feature

The priority for WHA establishment is known spawning, rearing, overwintering, and staging pools for populations of native, non-hybridized Westslope Cutthroat Trout that occur in small streams (S4). Priority for WHAs should be for populations that are naturally isolated above barriers that have evolved unique morphological and presumably genetic characteristics (e.g., Akolkolex River, Bull River, Kirkup Creek, Fording River). Select areas where there appear to be higher than average concentrations of fish (>20% of the adult population of a run) and/or where the habitat appears to be susceptible to impacts from human activities.

Size

Generally between 5 and 20 ha; however, the size of the WHA will vary depending on the stream system, feature to be protected, or inclusion of upstream reaches (S5, S6) necessary to achieve goals. Spawning and rearing areas could be larger if adult fish spawn or rear over several kilometres (1–5 km) of stream reach (i.e., Elk River, St Mary River).

Design

The WHA should include the entire feature of interest (e.g., spawning area) plus a 20 m core area and 20–30 m management zone determined from stream size.

Overwintering and staging pools have been identified in the Elk and St. Mary rivers (Westslope Fisheries 2003). Spawning habitat is typically found in smaller, low-gradient stream reaches that have abundant gravel substrate, shallow riffles, and good cover. Rearing habitat typically is found in very small tributaries and fisheries sensitive zones such as beaver ponds and back channels.

General wildlife measures

Goals

1. Prevent disturbance of Westslope Cutthroat Trout particularly during spawning and overwintering periods when adults tend to be congregated.
2. Maintain sufficient riparian vegetation to maintain stream temperatures within the natural range of variability and provide nutrient input, cover, stream bank stability, and shade.
3. Limit access to populations that may be sensitive to overharvest.
4. Maintain critical instream habitats including spawning and rearing habitat.
5. Maintain water quality sufficient to sustain fish, fish habitats, and aquatic ecosystems.
6. Maintain sufficient water to sustain fish, fish habitat and aquatic ecosystems through all life stages.
7. Maintain natural stream morphology and complexity.
8. Maintain structural integrity of riparian plant community, stream banks, and channel.
9. Maintain processes that lead to the creation of a wide variety of aquatic habitats similar to the local reference conditions.

Measures

Access

- Limit access through road closures, deactivation, or seasonal closures during critical times (e.g., overwintering and staging – 30 September to 15 April; spawning – 15 April to 15 July; rearing – 15 July to 31 March). Consult MWLAP for site-specific times.
- Do not place roads or crossing structures within WHA.

Harvesting and silviculture

- Do not harvest or salvage in the core area.
- When conducting silvicultural practices, minimize access developments as per above access measure and ensure natural processes for stream maintenance are not adversely affected. Consult MWLAP for site-specific recommendations.

Pesticides

- Do not use pesticides.

Range

- Control livestock use of riparian areas. Where assessments have determined that range practices have degraded or altered riparian and aquatic habitat, change management practices, and/or remediate to achieve properly functioning condition. Ensure livestock use does not impede natural recovery or other remediation efforts.
- Fencing could be recommended by the statutory decision maker.
- Plan livestock grazing to maintain desired plant community, stubble height, and browse utilization.

Recreation

- Do not develop recreational sites or trails.

Additional Management Considerations

Maintain riparian reserves on all S4 streams with or suspected to have pure Westslope Cutthroat Trout populations or S5 and S6 streams that are tributary to streams with Westslope Cutthroat Trout, where local managers deem it necessary to protect natural stream processes and limit erosion and sedimentation caused by forestry practices.

Information Needs

1. Determine status of population, specifically how many pure populations exist.
2. Determine the risk of extinction of non-pure populations and rank them based on potential to rehabilitate.
3. Investigate life history of adfluvial, fluvial, and lake resident Westslope Cutthroat Trout populations.

Cross References

Bull Trout, Rocky Mountain Tailed Frog

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Amphibians

Coeur d'Alene Salamander

Plethodon idahoensis

Original prepared by I.A. (Penny) Ohanjanian

Species Information

Taxonomy

The Coeur d'Alene Salamander is in the Plethodontidae family (lungless salamanders). Until recently, the Coeur d'Alene Salamander was considered by some authors to be a subspecies of Van Dyke's salamander (*Plethodon vandykei*) (Nussbaum et al. 1983). Recent genetic work and morphometric analysis, however, have confirmed that *P. idahoensis* is a distinct species (Howard et al. 1993; Wilson and Larsen 1999). There are no recognized subspecies.

Description

The Coeur d'Alene Salamander is a lungless, terrestrial salamander. They are blackish brown, with a yellowish throat patch and a yellow, orange, or mustard-coloured dorsal stripe with irregular margins. Occasionally, individuals with a reddish stripe are encountered. Females are larger than males (Lynch 1984) and may reach up to 130 mm in total length, with snout-vent lengths reaching 65 mm (Ohanjanian 2000a). Coeur d'Alene Salamanders have distinct parotoid glands at the rear of the head (Nussbaum et al. 1983), long legs, and short, slightly webbed toes (Cassirer et al. 1994).

Distribution

Global

The known distribution of the Coeur d'Alene Salamander is fragmented. Isolated populations are scattered throughout northern Idaho, western Montana, and southeastern British Columbia (Cassirer et al. 1994; Wilson et al. 1989, 1997).

British Columbia

Coeur d'Alene Salamanders are distributed in tributaries and seepages that drain into Moyie River, Duck Lake, Kootenay Lake, the Duncan Reservoir, Lower and Upper Arrow lakes, and St. Mary's River (Ohanjanian 1997a, 1998, 2000b; Dulisse 1999; L. Amos, pers. comm.). The species has recently (2001) been confirmed near Revelstoke, thereby extending the northern limits of its range by 120 km. In addition, this species has been confirmed in the West Kootenays (Kimberley and Cranbrook areas) (Ohanjanian, unpubl. data).

Forest region and districts

Southern Interior: Arrow Boundary, Columbia, Kootenay Lake, Rocky Mountain

Ecoprovinces and ecosections

SIM: CCM, MCR, SCM, SFH, SPM

Biogeoclimatic units

ICH: dw, mk1 (in MCR), mw2 (in CCM and SFH), wk1 (in CCM), xw (in SCM and SFH),

IDF: un (SFH)

MS: dk

Broad ecosystem units

AV, RO, SP (DP, DF, IH on steep south-facing slopes associated with talus habitats)

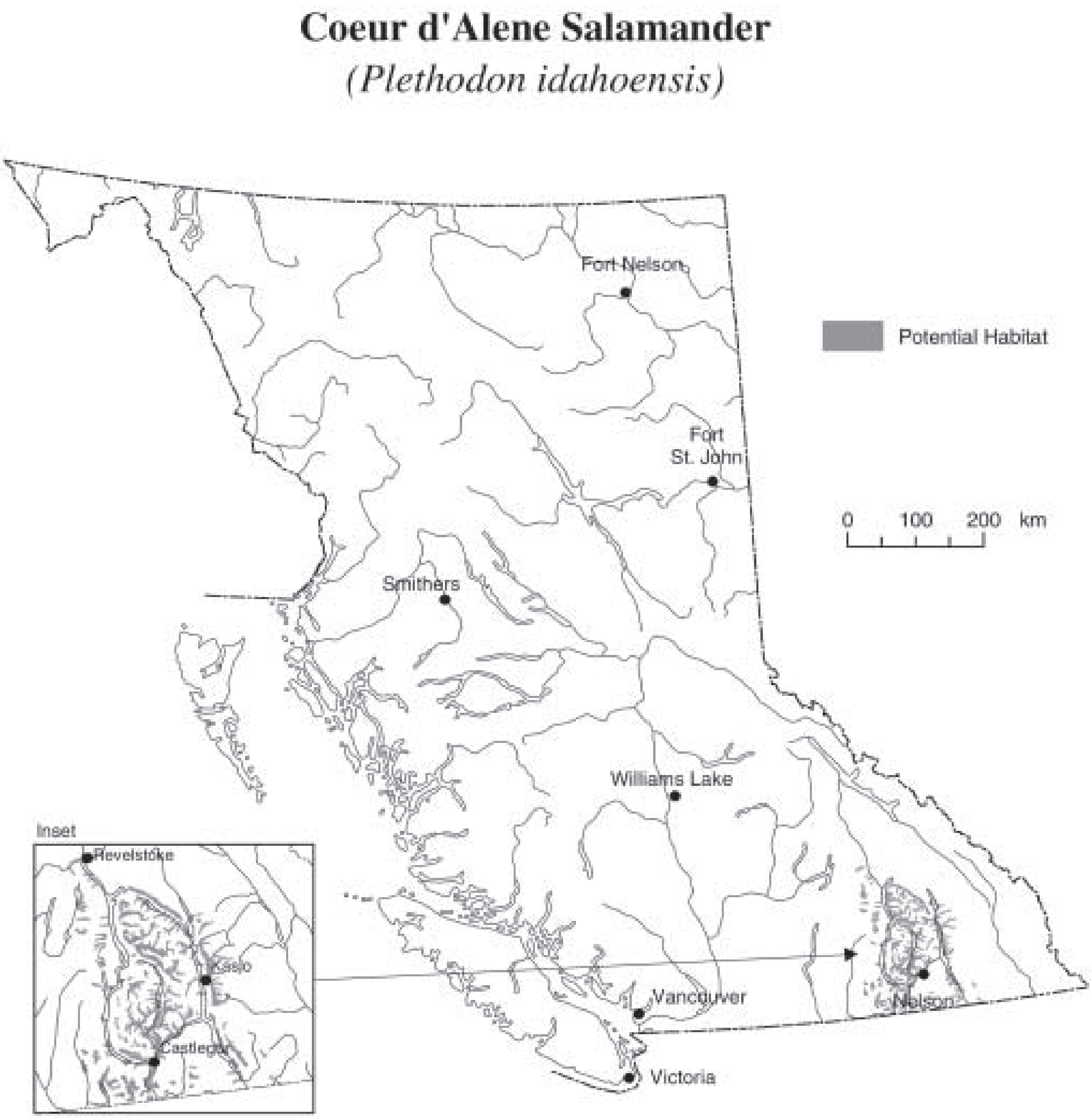
Elevation

500–1550 m (Groves et al. 1996; Wilson et al. 1997)

Life History

Diet and foraging behaviour

Coeur d'Alene Salamanders are nocturnal, and feed primarily on insects (Wilson and Larsen 1988). They



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. Recent records (2001, 2002) not included.

forage on the surface during wet periods in spring, summer and fall within suitable habitats (moist areas), usually near subsurface retreats, but they may, under optimal conditions, travel farther (Cassirer et al. 1994).

Reproduction

Mating occurs primarily in the late summer and fall but may also occur in the spring. Young hatch in early fall directly from eggs. There is no larval stage. Female Coeur d'Alene Salamanders lay eggs only in alternate years and are not reproductive until they are 4 years old (Lynch 1984).

Site fidelity

There is no information on movements of Coeur d'Alene Salamanders from site to site. Certain individuals appear to remain under specific cover objects at a site, but this is not consistent (Ohanjanian 2000a).

Home range

Home range size has not yet been determined; however, one individual is known to have moved at least 31 m over 14 days, and another was detected on a rainy night 50 m away from a waterfall area (Ohanjanian 1997b, 2000a).

Movements and dispersal

Although these salamanders spend much of the year in subsurface retreats, they are active above ground during the spring and fall (May through October) or during wet periods in the summer. During this time they will forage, mate, and disperse.

Since plethodontid salamanders require a damp environment for respiration and rehydration (Spotila 1972), and parts of their range in British Columbia are characterized by a dry, severe climate (Braumandl and Curran 1992), opportunities to disperse are likely poor and must coincide with relatively rare periods of extended rainfall. Some dispersal may occur on an elevational gradient, as they have been found at more than one location on a given watercourse (Ohanjanian 1998).

Habitat

Structural stage

3b: tall shrub
4: pole sapling
5: young forest
6: mature forest
7: old forest

Important habitats and habitat features

This species has highly specialized habitat requirements (Cassirer et al. 1994). A damp environment is essential for respiration and rehydration. Generally, Coeur d'Alene Salamanders occur in wet microhabitats associated with fissured bedrock or deep, wet talus (Cassirer et al. 1994; Ohanjanian 1997a). They require moist underground rocky retreats to avoid desiccation in summer and freezing in winter. Important habitat features with these characteristics include waterfall splash zones; rock seepages; fissured bedrock in association with streams; and deep, wet, talus. Occupied watercourses vary in size and individuals have been found on rock walls where surficial water is present for only a part of the year (Ohanjanian 1997b).

Suitable habitat generally occurs in areas of steep topography where bedrock is near the surface. Areas overlain with unconsolidated glacial or alluvial deposits do not provide underground habitat for Coeur d'Alene Salamanders and these features may limit their distribution (Wilson and Larsen 1998).

In spring, summer, and fall, rock slabs, moist cracks in bedrock, deep moss, and coarse woody debris in the wetted areas of streams provide seasonal cover near the surface. However, when it is dry or cold, Coeur d'Alene Salamanders must be able to retreat deep into bedrock or talus.

Overstorey vegetation in forested areas adjacent to rocky retreats and streams reduces evaporation caused by incident solar radiation and raises the humidity of the substrate. Minimum canopy cover at stream sites in the United States was 42% with a mean of 83% ± 15% (Cassirer et al. 1994). At seepage sites, this mean is lower (57% ± 5%), probably because the terrain is often near vertical at seepages. The forests between streams and seepages provide the Coeur d'Alene Salamander with additional opportunities for foraging and may allow the dispersal of juveniles from one watercourse to another during prolonged rain events.

Conservation and Management

Status

The Coeur d'Alene Salamander is on the provincial *Blue List* in British Columbia. It is considered a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	Canada	Global
S3	S3	S2	N3	G4

Trends

Population trends

In British Columbia, the Coeur d'Alene Salamander is known from 44 sites on 41 distinct watercourses in 16 localities. Although no data are available on absolute abundance or trends, populations are likely small, as encounter rates seem low when compared with some sites in the Unites States (Ohanjanian 1997a).

Habitat trends

As the human population increases, more water may be diverted from streams for community watersheds. Ongoing road construction may also reduce habitat availability.

Threats

Population threats

In addition to being small, populations also tend to be "scarce and clustered" and some are likely isolated (Dupuis and Ohanjanian 1997). This species' limited dispersal ability and sensitivity to desiccation may impede genetic exchange or recolonization of sites. In addition, its low reproductive rate makes it difficult for populations to recover should habitat loss, disturbance, or direct mortality cause it to decline. Thus, it may be vulnerable to local extirpations.

Habitat threats

The greatest threat to this species' habitat is the alteration of the hydrology of occupied wet microhabitats (i.e., fissured bedrock or deep, wet talus, and associated foraging habitat). The main activities that are likely to result in changes to the hydrology of known Coeur d'Alene Salamander sites are forest management and road development (Cannings et al. 1999). If climate change results in lower precipitation or decreases in snowpack, populations associated with seepages and low volume creeks will likely dry out and be extirpated. Blasting for road maintenance or widening can also eliminate populations (Ohanjanian 1997a, 1997b; A.G. Wilson, pers. comm.)

Alterations in hydrology include upslope water diversion (may desiccate downslope habitat), loss of overstorey vegetation (decreases substrate moisture and therefore reduces foraging opportunities or prevents movement of salamanders between sites), and flooding from increases in peak flows. Populations that occupy seepages flowing along rock faces may be particularly vulnerable to decreases in flow caused upslope, as many of these sites have low flow for much of the year.

Structural changes to the habitat may also threaten Coeur d'Alene Salamanders. These include sedimentation or slumping, which may clog salamander retreats; blasting of rock for road construction, or culvert construction, which may directly kill salamanders; and silvicultural practices such as herbicide application and burning, which alter vegetative structure, abundance of coarse woody debris, and the invertebrate prey base. Operation of heavy equipment and cross-stream yarding may directly kill salamanders and destroy their cover objects.

Legal Protection and Habitat Conservation

The Coeur d'Alene Salamander is protected, in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act*.

Of the 44 known occurrences, one is in a provincial park, three are in proposed Goal 2 Protected Areas, and one is in a Ministry of Forests recreation site. The remaining occurrences are on private land, highway right-of-ways, or Crown land.

The greatest protection the Crown land sites can receive, under the results based code, is the Best Management Practices for S2 and S3 streams. These practices recommend a "no logging" reserve zone (30 and 20 m wide, respectively) as well as a 20 m management zone. Guidelines for smaller streams (i.e., S4, S5, and S6) do not adequately protect Coeur d'Alene Salamanders. Ephemeral rock seepages are not protected under the results based code. Some sites may be established as wildlife habitat features under the results based code.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- ❖ Maintain hydrological characteristics (surface and subsurface) of slopes above and/or influencing downstream hydrology and micro- and macro-drainage patterns of streams and seepages within the range of the Coeur d'Alene Salamander.
- ❖ Maximize connectivity between known occurrences and suitable habitat (wet talus and fissured bedrock associated with water below 1550 m within the range of the Coeur d'Alene Salamander). Riparian connectivity and/or forested habitat in addition to underground passages are expected to provide the principal dispersal avenues for juveniles.
- ❖ Wherever possible, increase forest retention on stream reaches adjacent to WHAs.
- ❖ Avoid activities that affect the hydrology, micro-climate, or rock structure, particularly blasting, between neighbouring occurrences.

Wildlife habitat area

Goal

Protect populations by maintaining the structural and hydrological integrity of known subsurface retreats and adjacent above-surface foraging and breeding habitat (adjacent forested areas).

Feature

Establish WHAs at known occurrences within natural habitats. Use the wildlife habitat feature designation to address occurrences within human-made habitats (i.e., road structures).

Size

Typically, <20 ha; however, the size will be based on the extent of suitable habitat, microclimate, and hydrological considerations.

Design

The WHA should consist of a core area plus a 20–40 m management zone. The core area should be delineated to include all suitable habitat (i.e., wet, fissured bedrock or deep wet talus) plus adjacent suitable foraging habitat (i.e., forested habitat within 50 m of the wet bedrock or talus). The management zone should be designed to protect the windfirmness and microclimate of the core area.

General wildlife measures

Goals

1. Maintain microhabitat conditions by ensuring streamside moisture levels and natural flow regimes of watercourses are unaltered.
2. Ensure that the integrity of structural habitat (fissured bedrock and/or talus) remains intact and is protected from destruction by blasting or siltation.
3. Protect population from physical disturbance and direct mortality.
4. Prevent compaction of interstitial spaces.
5. Ensure WHA boundaries are windfirm.

Measures

Access

- Do not construct roads unless there is no other practicable option. When roads are determined to be necessary, locate downslope from the WHA to prevent siltation. If roads must be built upslope, ensure every measure is taken to prevent water diversion, which can lead to desiccation of habitat downslope.
- Do not build stream crossings unless there is no other practicable option. Where crossings are determined to be necessary, use open-bottomed structures (e.g., bridges or log culverts). Ensure adequate silt and sediment control measures are implemented.
- Do not remove rock or talus.

Harvesting and silviculture

- In core area, do not harvest or salvage, except when there are serious forest health concerns and disturbance to aquatic habitats are minimized.
- Do not harvest within management zone between 1 May to 30 October. Up to 30% basal area or greater, where topographic shading dominates the microsite, may be removed in the management zone to create a windfirm boundary zone and maintain the microclimatic conditions of the core area.
- Leave wildlife trees, deciduous trees, and shrubs in the management zone.
- Leave coarse woody debris, moss, and understorey intact.
- Do not disturb substrate.
- Burning should not be carried out in the management zone or core area.

Pesticides

- Do not use pesticides.

Recreation

- Do not establish recreation sites.

Additional Management Considerations

Apply best management practices, according to riparian management recommendations, on streams where Coeur d'Alene Salamanders are present.

Information Needs

1. Movement and distribution along creeks.
2. Information on species' occurrence on eastern slopes of Purcell Mountains (near Kimberley).
3. Dispersal and ability to move between sites.

Cross References

Rocky Mountain Tailed Frog

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Tiger Salamander

Ambystoma tigrinum

Original prepared by Mike Sarell

Species Information

Taxonomy

The Tiger Salamander, *Ambystoma tigrinum*, belongs to the family Ambystomatidae (mole salamanders). Six subspecies are currently recognized (Green 1999), although as many as 10 have been proposed (Collins 1981). The taxonomy of Tiger Salamanders is uncertain and further taxonomic research may differentiate *A. tigrinum* into several different species. The "Blotched" Tiger Salamander (*A. tigrinum melanostictum)* occurs in British Columbia (Green 1999).

Description

Terrestrial adults are large (14–22 cm snout-vent-length [svl]) and robust with small eyes, a broad rounded snout, 13 costal groves, two tubercles on underside of feet, and no parotid glands. Colour pattern and markings are extremely variable but may be yellow or whitish mottling on a darker brown, grey, or black background. Larvae (8–38 mm svl) have large heads and gills that are longer than the length of the head (see Corkran and Thoms 1996). Fully aquatic adults (paedogens) can be extremely large with very robust gill apparatus. Only the Long-toed Salamander (*Ambystoma macrodactylum*) is sympatric with Tiger Salamanders in British Columbia and is easily differentiated by its much smaller size, a long third toe on the hind feet, and an irregular green-yellow stripe along the back, on a dark background.

Distribution

Global

The "Blotched" Tiger Salamander is widely but patchily distributed across southern Canada (Alberta, British Columbia, Saskatchewan) and the western United States (Washington, Oregon, Idaho, Montana, North and South Dakota, Wyoming, Nebraska, Colorado, Utah; Schock 2001).

British Columbia

In British Columbia, Tiger Salamanders occur in the southern Okanagan, north to Peachland; in the lower Similkameen, west to Keremeos; and in the Sidley and Kettle River valley, east to Christina Lake (Orchard 1991; Sarell and Robertson 1994; Sarell 1996; Sarell et al. 1998). This relatively small distribution in three drainages is weakly linked north of the international boundary, but is contiguous throughout its range to the south in Washington State (Leonard et al. 1993; Sarell 1996). Tiger Salamanders may occur in the southern part of the East Kootenay Trench. A disjunct population (possibly introduced) was found very close to the border in Eureka, Montana (J. Reichel, pers. comm.).

Forest region and districts

Southern Interior: Arrow Boundary, Okanagan Shuswap

Ecoprovinces and ecosections

SIM: SFH(?[1])
SOI: OKR, NOB, NOH, SOB, SOH, STU(?)

Biogeoclimatic units

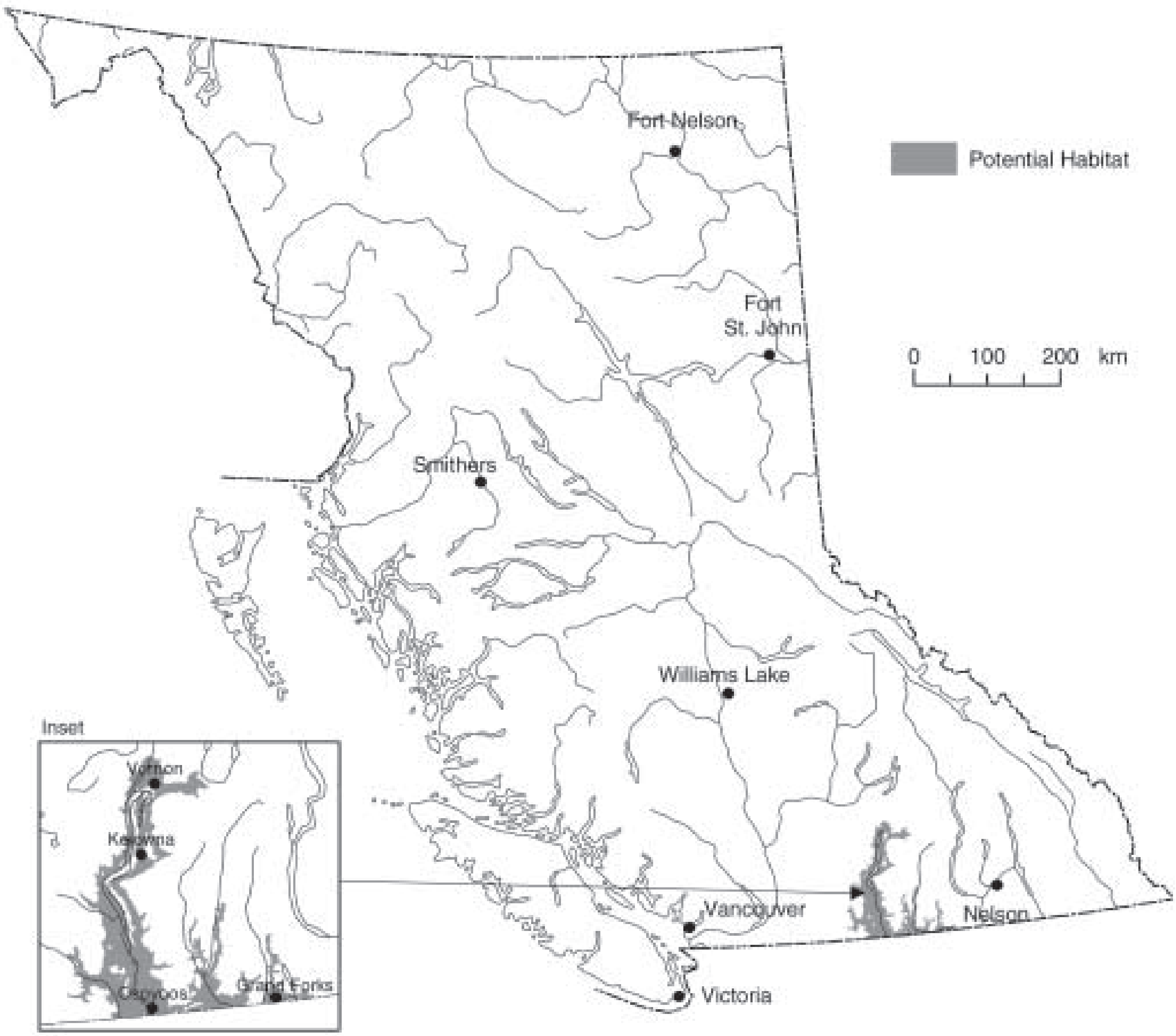
BG: xh1
IDF: dk1, dk2(?), dm1, xh1
ICH: dw(?), mk1(?), mw2(?), xw
PP: dh1, dh2(?), xh1, xh1a

Broad ecosystem units

Terrestrial: AB, BS, CF, CR, DF, DP, OV, PP, RO, SS
Aquatic: LS

1 (?) Indicates that the range extent has not been determined.

Tiger Salamander
(Ambystoma tigrinum)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Elevation

Tiger Salamanders have been found from valley bottoms (300 m) up to 1250 m in British Columbia (Orchard 1991). Populations at higher elevations are usually found in areas with well-developed soils and a grasslands component.

Life History

Diet and foraging behaviour

Terrestrial adults are usually only seen travelling on land and at breeding ponds. Little is known of their terrestrial, subterranean, foraging behaviour. It is likely that much of the terrestrial foraging occurs in burrows, where arthropods and other invertebrates are encountered. Prey is known to consist of a large variety of invertebrates and occasionally small vertebrates. Aquatic forms (larvae, neotenes, and paedogens) prey on aquatic invertebrates and small vertebrates. A small percentage of terrestrial and aquatic morphs are cannibalistic, ensuring that under extreme conditions there will be sufficient food to perpetuate the species (Collins and Cheek 1983).

Reproduction

Reproduction occurs from March through August. Sexual maturity is generally reached in the first year, but can be delayed (neotony). In early spring, adult Tiger Salamanders congregate at aquatic breeding sites. Females deposit several hundred eggs, although more than 5000 can be produced by very large females in some subspecies (Bishop 1943; Rose and Armentout 1976). Eggs are deposited singly but they may be deposited over a small area. Females often attach eggs to submerged vegetation, rocks, or twigs in shallow water (<1 m deep). This usually occurs in April or May. Most terrestrial adults have left the breeding site by the end of May or June. Larvae hatch in 2–3 weeks and may metamorphose and leave the water at 3–4 months, usually during fall rains. Growth rates vary between ponds (Richardson et al. 2000a, 200b). Neotony can occur under certain conditions, usually related to water chemistry (low iodine concentrations), food availability, and temperature. Paedogensis occurs when the larval form is retained and sexual maturity reached. This usually occurs in permanent water bodies, without fish. Paedogens have been documented at two sites in British Columbia and there is some evidence for the possibility of a third site (Sarell 1996).

Site fidelity

It is not known how philopatric individuals are to specific breeding sites but this species regularly breeds at several sites in the south Okanagan. Breeding site fidelity is unlikely if a breeding site is dry and another is detected or found. This tendency would follow that of the California Tiger Salamander (*Ambystoma californiense)* in which the majority of the population return to their natal pond but 20% were found to travel to new ponds (Trenham 1998).

Home range

Home range is not known but evidence suggests it is very limited (Richardson et al. 2000b). Richardson et al. (2000a) found that during the summer, Tiger Salamanders generally did not move far daily or even weekly, often remaining within a 5 m radius, but occasionally moving 10–100 m. The largest recorded movement was 250 m. This information was derived from individuals implanted with radio transmitters. Other observations of terrestrial adults have found them more than 1 km from possible breeding sites (Sarell 2000). The California Tiger Salamander has been found to usually return to their natal ponds; however, about 20% of the population venture to other ponds within 800 m (Trenham 1998). This information suggests a larger home range for at least some of the population.

Movements and dispersal

Movements and dispersal often coincide with specific environmental conditions, particularly temperature and rainfall (Loredo and Van Vuren 1996; Richardson et al. 2000b). Terrestrial adults migrate from terrestrial habitats to aquatic breeding sites in late winter or early spring (March and April). Richardson et al. (2000a) found that during the summer, Tiger Salamanders did not move >150 m from breeding locations in 1998 and not more than 500 m in 1999 (Richardson et al. 2000b). Semlitsch

(1998) found that adult salamanders from six species in the genus *Ambystoma* were found an average of 125.3 m from the edge of aquatic habitats. However, adult salamanders also have been found more than 1 km, and up steep slopes, from the nearest, potential breeding site (Sarell and Robertson 1994; Sarell 2000). Newly metamorphosed individuals emigrate from ponds to terrestrial habitats in August and early September, during heavy night rains.

Habitat

Structural stage

Tiger Salamanders likely prefer a structural stage of 2 (herb) and 3 (shrub/herb) but certainly use other structural stages where the forests are open and soils are suitable.

Important habitats and habitat features

Aquatic

The Tiger Salamander breeds in a variety of temporary and permanent aquatic habitats. In the south Okanagan many of these are small and frequently alkaline. Water depth, emergent vegetation, and an absence of predatory fish species are important characteristics of breeding sites (Orchard 1991). Tiger Salamanders typically lay their eggs in shallow, warm water that is <1 m deep. Emergent vegetation provides cover, a supply of invertebrates, and substrate for attaching eggs, but is not characteristic of all breeding sites.

Aquatic habitats that retain water until late July or August provide consistent breeding over those water bodies that dry prior to larvae metamorphosing. Neotenes (extended larval morphs) and paedogens (aquatic gilled adults) require permanent water bodies that do not freeze solid during the winter and preferably lack predatory fish. These water bodies provide nuclei for populations, especially during extended droughts.

Ephemeral water bodies (e.g., White Lake) provide extensive breeding opportunities during wet years, replenishing populations after dry years. Ephemeral ponds also permit range expansions during wet years. These small and shallow water bodies are especially important where deep lakes have been stocked with predatory fish.

Terrestrial

Important terrestrial habitats include riparian habitats adjacent to aquatic breeding sites, open sagebrush grasslands, and open forests. Tiger Salamanders spend most of their lives in underground refuges, such as small mammal burrows, particularly those of Great Basin Pocket Mouse (*Perognathus parvus*) and pocket gophers (*Thomomys talpoides*) (Vaughan 1961; Richardson et al. 2000b). The northern distribution of the Tiger Salamander in North America appears to be closely linked to the distribution of pocket gophers (Sarell 1996). Rodent burrows may be the limiting factor in terrestrial habitats as they provide abundant opportunities to gain subterranean access, have an abundance of prey, and provide adequate retreat depth for overwintering. Tiger Salamanders also retreat under coarse woody material or dig burrows (Semlitsch 1983). These retreats are used during the day or for short periods during the active season, and may be important during critical times, particularly juvenile dispersal (Richardson et al. 2000a).

Conservation and Management

Status

The Tiger Salamander is on the provincial *Red List* in British Columbia. In Canada, the southern mountain population is designated as *Endangered* (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	BC	ID	MT	WA	Canada	Global
S4	S2	S5	S5	S3	N5	G5

Trends

Population trends

Population size and trend are not known. Populations may fluctuate significantly between years and annual recruitment is highly variable (Semlitsch 1983; Richardson et al. 2000b). In dry years, shallow ponds may dry up early and result in total reproductive failure. This has been observed at many sites in British Columbia (Orchard 1991; Sarell and Bryan 1993).

Anecdotal information strongly suggests that Tiger Salamanders in British Columbia are declining (Orchard 1991). Forty-one historic breeding sites were known in British Columbia of which about 16 still had successful breeding (Sarell 1996).

Habitat trends

In British Columbia, Tiger Salamanders occupy habitat that is greatly desired and impacted by people. The highest rate of habitat loss has been in the south Okanagan, primarily due to residential and agricultural developments. The expanse of roadways and increased traffic extend this influence into unsettled habitats. To a lesser extent, off-road traffic, invasive species, and concentrated livestock use appears to impair the suitability of relatively natural habitat (Orchard 1991; Sarell 1996; Schock 2001).

In the late 1980s it was calculated that about 10% of ecosystems in the south Okanagan remained relatively undisturbed (Redpath 1990). About half the riparian habitat in the south Okanagan Valley has been lost to urban or agricultural development over the last 50 years (Cannings et al. 1999). Human population growth, roads, and volume of traffic in the south Okanagan are expected to continue to increase.

Road-use statistics of Highway 97 in the south Okanagan record a range of 2872 to 20 017 vehicles per summer day (1–14 vehicles per minute) during the season when Tiger Salamanders are active (MOTH 1999). Despite lower traffic volumes at night, even the lowest level of two vehicles per minute provides very little chance of a Tiger Salamander successfully crossing the road.

Most known Tiger Salamander sites are on or surrounded by private land or rangeland. Some important habitats have been acquired by The Nature Trust of BC and BC Parks. Breeding habitats have been unintentionally created through the development of water impoundments and waste water lagoons.

Threats

Population threats

In British Columbia, populations in the valleys are extremely prone to heavy losses due to extensive land uses and high levels of traffic. It is quite possible that much of the Okanagan range will be lost and the remaining undeveloped and secured lands could be significantly impacted by road traffic. Lakes that support paedogenic populations continue to be managed for introduced fish. Paedogens maintain this species range during prolonged droughts.

Although Rainbow Trout (*Oncorhynchus mykiss*) are sympatric, most breeding sites are void of fish. Introduction of trout for sport fisheries is a major threat to Tiger Salamander populations in British Columbia. Predatory fish may compete for prey and feed on Tiger Salamander eggs and larvae (Orchard 1992). At least five major breeding populations in British Columbia have been lost or significantly impacted by fish stocking programs (Orchard 1991; Sarell 1996). This does not include the oxbows along the Okanagan River that are now teeming with non-native fish such as bass. Introduced fish can also carry and spread diseases that native amphibian species have little or no defence against.

Pesticides, fertilizers, and other contaminants are known to impact Tiger Salamanders (Power et al. 1989). Because they prey on a variety of invertebrates and vertebrates, Tiger Salamanders are sensitive to bioamplification (concentration of contaminants). Pesticides can result in direct and indirect effects that impact growth and development, reproduction, behaviour, as well as habitat and food quantity and quality (Bishop 1992). Even some inactive ingredients in pesticides, such as dispersants or wetting agents in herbicides, can impact gill respiration in tadpoles (Seburn and Seburn 2000).

Runoff from nitrate fertilizers can reduce the fitness of individuals by reducing activity and feeding, and increasing deformities in larvae of some amphibians (Seburn and Seburn 2000).

Infectious diseases have been found in Tiger Salamanders (Seburn and Seburn 2000; Davidson et al. 2000). Mass mortality at four lakes in Utah occurred from bacteria (Worthylake and Hovingh 1989). Chytrid fungus (genus *Batrachochytrium*) and *Ranavirus* have also been implicated in the declines or die-offs of Tiger Salamanders (Schock 2001). In British Columbia, a larval population experienced a die-off although it is not known what caused the event.

Habitat threats

The loss, alteration, and fragmentation of suitable habitat due to urban and agricultural development have been extensive in the south Okanagan. About half of the riparian habitat in the south Okanagan Valley has been lost to urban or agricultural development over the last 50 years (Cannings et al. 1999). Irrigation practices or water control systems, which lower water levels, can also impact Tiger Salamanders by stranding eggs, larvae, and neotenes. Irrigation developments also have enabled the conversion of terrestrial habitats into agricultural production.

Impacts from livestock grazing include soil compaction, trampling of wetland banks or edges and burrows, loss of riparian vegetation, and increased nutrient input to water (Orchard 1991; Richardson et al. 1998). If water quality is reduced at breeding sites due to livestock grazing, mass die-offs of Tiger Salamanders may occur due to increases in *Acinetobacter bacterium* (Worthylake and Hovingh 1989). Nutrient loading can also lead to dramatic increases of other pathogens or toxic levels of nitrites, especially during dry years (Worthylake and Hovingh 1989; Bishop 1992). Soil disturbances around the pond can also increase the rate of infilling and eventual loss of breeding habitat (Harvey et al. 2000). Heavy livestock use near the ponds can cause the collapse of small mammal burrow entrances, needed for aestivation (Harvey et al. 2000). Overall, the effects of livestock grazing are much less than many other anthropogenic effects, given the apparent reproductive and survival success in many areas that are grazed. The extent of the effects are probably linked to the intensity and timing of grazing. It is very unlikely that many Tiger Salamanders are trampled above ground, given that livestock do not travel much at night, when the salamanders are above ground.

Roads that intersect aquatic breeding and terrestrial habitats can result in increased road mortality during seasonal migrations. Richardson et al. (1998) reported up to 50 road mortalities on one day near one breeding site during September migrations. Mortalities from vehicle traffic may be one of the most significant effects, beside outright loss of habitats (Seburn and Seburn 2000). Prolonged and heavy all-terrain vehicle traffic may also significantly reduce habitat suitability.

Periodic drought is a natural limiting factor for Tiger Salamander populations (Orchard 1991). Annual and seasonal variations in precipitation and ground water flows may result in some ponds or wetlands drying up completely prior to metamorphosis of larvae. Human use of water for agricultural purposes may further reduce water levels and exacerbate these impacts.

The eggs of some amphibian species are vulnerable to increased UV radiation, resulting in reduced hatching success. Tiger Salamanders may be sensitive to the impacts caused by increased UV-B radiation (Seburn and Seburn 2000).

Legal Protection and Habitat Conservation

The Tiger Salamander is protected in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act*.

Tiger Salamanders require the protection of aquatic breeding habitat and nearby terrestrial habitats. Prior to the recent designation of some provincial parks, only 6% (4599 ha) of suitable Tiger Salamander habitat in the south Okanagan was currently designated as conservation lands (MELP 1998). Approximately 58% (42 241 ha) of suitable habitat is on Indian Reserves or private land and 36% (26 346 ha) was found on Crown land. Key areas that are afforded some protection are the White Lake Basin, South Okanagan Grassland Provincial Park, and the South Okanagan Wildlife Management Area.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Maximize connectivity between known or suitable aquatic breeding sites, terrestrial foraging, and overwintering habitats by reducing agricultural and residential developments, as well as managing the impacts from traffic through these areas.

Wildlife habitat area

Goal

Maintain or recover the integrity of breeding and terrestrial habitats, ensuring the connectivity between these habitats is unimpeded.

Feature

Establish WHAs at breeding sites where breeding is known to occur.

Size

Most WHAs will be between 5 and 25 ha; however, the size of the WHA will ultimately depend on the size and number of wetlands included and area of suitable upland habitat.

Design

The WHA should include a core area and may include a management zone. The core area should include the aquatic breeding site(s) and suitable uplands within ~250 m to protect most of the aestivation habitat. A management zone may be included to capture high quality habitat or to provide connectivity between populations.

General wildlife measures

Goals

1. Minimize disturbance during the breeding season.
2. Minimize road mortality.
3. Maintain water quality.
4. Maintain water levels.
5. Minimize soil disturbance and trampling of burrows.
6. Maintain important habitat features (i.e., small mammal burrows, riparian and emergent vegetation, and non-compacted soils).
7. Maintain or remediate riparian and aquatic habitats to a properly functioning condition.

Measures

Access

- Do not construct roads, deactivate temporary road structures, and close roads during critical times, as recommended by MWLAP. Drift fences and culverts may be required by the statutory decision maker for locations where road mortality is extensive.

Harvesting and silviculture

- Do not harvest. When approved, selective harvesting methods are preferred.
- Minimize ground disturbances and do not scarify harvested areas.
- Do not place landings within core or management zone.
- Do not stock above natural densities so that open forest and grassland openings are maintained, as per a NTD4 fire maintained ecosystem.
- Salvage harvesting should follow the same guidelines as stated above.

Pesticides

- Do not use pesticides.

Range

- Plan livestock use in the core area to meet objectives described in general wildlife measures goals. Exclusion fencing may be required by the statutory decision maker to meet objectives.
- Do not place livestock attractants within WHA.

Additional Management Considerations

Minimize road traffic.

Prohibit fish stocking in WHAs or any fishless water body.

Ensure all-terrain vehicles do not have access to critical habitats and prevent incompatible recreation activities.

Ensure irrigation intake lines are screened.

Ensure breeding sites do not experience water extraction to the point that reproduction is impaired.

Maintain integrity of riparian areas of adjacent permanent and non-permanent wetlands.

Encourage private land stewardship where important habitats extend beyond Crown lands.

Information Needs

1. Determine the range and biogeoclimatic limits of the species.
2. Identify critical habitat feature requirements.
3. Determine the effects of contaminants and threats from infectious diseases.

Cross References

Badger, Burrowing Owl, Great Basin Spadefoot, Sandhill Crane

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Coastal Tailed Frog

Ascaphus truei

Original[1] prepared by Agi Mallory

Species Information

Taxonomy

Phylogenetic studies have determined that tailed frogs belong in their own monotypic family, Ascaphidae (Green et al. 1989; Jamieson et al. 1993). Recent phylogeographic analysis has determined that coastal and inland assemblages of the tailed frog are sufficiently divergent as to warrant designation as two distinct species: *Ascaphus truei* (coastal) and *Ascaphus montanus* (Rocky Mountain) (Ritland et al. 2000; Nielson et al. 2001). The divergence of coastal and inland populations is likely attributable to isolation in refugia in response to the rise of the Cascade Mountains during the late Miocene to early Pliocene (Nielson et al. 2001).

The Coastal Tailed Frog and Rocky Mountain Tailed Frog are the only members of the family Ascaphidae and are considered the most primitive frogs in the world, representing the basal lineage of the anurans (Nielson et al. 2001).

Description

Tailed frogs have unique morphological adaptations to life in fast-flowing mountain streams. They are the only frog species in North America that breed in cold mountain streams. Adults and juveniles are small (2.2–5.1 cm) with a large head, a vertical pupil, and broad and flattened outer hind toes. They lack tympana (ear membranes) and the ability to vocalize, presumably adaptations to the constant sound of rushing water. The species is commonly known as the tailed frog because males have a short, conical "tail" with which to inseminate females. Adults have a grainy skin that can vary in colour from tan, to chocolate brown, to olive green (Metter 1964; L.A. Dupuis, pers. comm.); fine black speckling generally occurs on paler individuals. There is often a distinct copper bar or triangle between the eyes and snout, with green undertones (Metter 1964).

Tadpoles are roughly 11 mm in length upon hatching, and can reach up to 65 mm long prior to metamorphosis (Brown 1990). They possess a wide flattened oral disc modified into a suction mouth for clinging to rocks in swift currents and grazing periphyton (Metter 1964, 1967; Nussbaum et al. 1983), a ventrally flattened body, and a laterally compressed tail bordered by a low dorsal fin. They are black or light brownish-grey, often with fine black speckling; lighter flecks may or may not be present (L.A. Dupuis, pers. comm.). The tadpoles usually possess a white dot (ocellus) on the tip of the tail and often have a distinct copper-coloured bar or triangle between the eyes and snout. Hatchlings lack pigmentation, and are most easily characterized by the large, conspicuous yolk sac in the abdomen.

Distribution

Global

The Coastal Tailed Frog occurs from northwestern California to Portland Canal and Nass River, north of Prince Rupert, British Columbia throughout the temperate Coast Mountains (Corkran and Thoms 1996; Dupuis and Bunnell 1997).

British Columbia

In British Columbia, the Coastal Tailed Frog is restricted to cool permanent mountain streams within the windward and leeward drainages of the Coast Mountains. The distribution extends from the Lower Mainland in the Fraser Basin to Portland Canal and the Nass River on the north coast (Dupuis and Bunnell 1997; Dupuis et al. 2000). Occurrences become scattered and tadpole densities decrease

1 Volume 1 account prepared by L. Dupuis.

Coastal Tailed Frog
(Ascaphus truei)

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

north of latitude 54° N. The most westerly occurrences are from islands on the mid- and northern coast of British Columbia, and from Namu and Boswell Inlet in the Hecate Lowlands (Dupuis et al. 2000). The most easterly occurrences are from the Cayoosh Ranges between Pemberton and Lillooet, Cathedral Provincial Park, south of Princeton, and Penticton (Dupuis et al. 2000; Gyug 2000). In the eastern portion of its range, cold creek temperatures limit distribution (Dupuis and Friele 2003).

Forest regions and districts

Coast: Campbell River (mainland), Chilliwack, North Coast, North Island (mainland), Squamish, Sunshine Coast

Northern Interior: Kalum, Skeena Stikine

Southern Interior: Cascades, Okanagan Shuswap (Penticton)

Ecoprovinces and ecosections

COM: CPR, EPR, HEL, KIM, KIR, NAM, NPR, NWC, OUF, SBR, SPR

GED: FRL, GEL

SOI: HOR, LPR, OKR, PAR, SCR, STU

Biogeoclimatic units

AT: p

CWH: dm, ds1, ds2, ms1, ms2, vh1, vh2, vm, vm1, vm2, wm, ws1, ws2, xm1

ESSF: dc2, mw, wv, xc

ICH: mc2

IDF: dk2, ww, xh1

MH: mm1, mm2

MS: dm2

Broad ecosystem units

CB, CR, FS, RR, RS, SM, SR, YB
CH, CW, FR, HS, MF – on south-facing slopes only
AV, RR, WR, (SS in IDFdk2, IDFww)
SF (into MSdm2 in OKR, STU)

Elevation

From sea level to 2140 m

Life History

Diet and foraging behaviour

Adults and juveniles forage primarily at night along the creek on a variety of items, including spiders and other terrestrial arthropods such as ticks, mites, collembolans (snow fleas), and various insects as well as snails (Metter 1964). Unlike most frogs and toads, tailed frogs do not have their tongue attached at the front of their mouth and therefore lack the ability to flip it out to catch prey (Green and Campbell 1984).

Tailed frog tadpoles are primary consumers that feed largely on diatoms that they scrape from submerged rocks (Metter 1964; Bury and Corn 1988). Other components of their diet include conifer pollen and small quantities of filamentous algae. In some streams, tailed frog tadpoles may function as the dominant herbivore (Lamberti et al. 1992).

Reproduction

Tailed frogs are the longest lived anuran species (15–20 years), and have the longest larval period and longest time to sexual maturity of all North American frogs (Brown 1975, 1989). They reach sexual maturity at 8 or 9 years of age (Daugherty and Sheldon 1982). Courtship takes place in the water in early fall (September–October). Tailed frogs are among the few frog species worldwide with internal fertilization (Green and Campbell 1984). The sperm stays viable in the female's oviducts until egg laying in June or early July. Each female produces a double strand of 44–85 colourless, pea-sized eggs that she attaches to the underside of a large rock or bolder in the stream in late summer (Metter 1964; Nussbaum et al. 1983). Although eggs are difficult to find, previous studies have shown that eggs are generally found close to headwaters (Brown 1975; Adams 1993).

The embryos emerge approximately 6 weeks after the eggs are deposited. They feed on a yolk sac which sustains them through the winter in the natal pool until their suctorial mouth is fully developed, after which they become more mobile (Metter 1964; Brown 1975). The tadpole stage lasts between 2 to 4 years prior to metamorphosis (Metter 1964; Brown 1990). However, 1-year larval cycles have been observed for the Coastal Tailed Frog in northern California (Wallace and Diller 1998). Variation in the age at metamorphosis appears to reflect differences in climatic conditions throughout the species range (Bury and Adams 1999).

Home range

Home range is not known. A study on age-specific movement patterns of Rocky Mountain Tailed Frogs found that adults remain closely associated with their natal stream throughout their lives, often not moving more than 20 m per year and between years (Daugherty and Sheldon 1982). In the Coast Range, adults have been reported several hundred metres from a stream's edge during wet weather (Bury and Corn 1988; Dupuis et al. 1995; Gomez and Anthony 1996; Wahbe et al. 2000). Climatic conditions likely favourable for tailed frogs (e.g., high humidity, extended periods of rain) along the coast may enable adults to occupy larger home ranges or move longer distances.

Movements and dispersal

Data on movement and dispersal of Coastal Tailed Frogs for all life history stages are limited. Tadpoles are relatively sedentary but movements of up to 65 m have been recorded in old-growth streams in the Squamish area (Wahbe 1996). Given that eggs are generally deposited in the headwaters near the source of the stream (Brown 1975; Adams 1993), larval movement is thought to be primarily downstream (Wahbe et al. 2000). Tadpoles can be either nocturnal or diurnal, and may alter their behaviour to avoid detection by predators such as the Coast Giant Salamander (Feminella and Hawkins 1994).

Adults generally remain close to stream banks, and may move upstream either for refuge during the summer months or to lay eggs. A recent study in the Chilliwack Valley found Coastal Tailed Frogs in mature forests primarily within 5 m of the streamside, with a maximum distance of 45 m (Matsuda 2001). This study showed that, in clearcut sites, a higher proportion of frogs were caught at distances >45 m away, suggesting that frogs move beyond riparian zones in disturbed habitats when climatic conditions are favourable. A recent study in the Merritt area found only adult males or immature females on streams without larvae during September, which indicates that adult females are less likely to disperse during the breeding season (Gyug 2000).

Some evidence shows that newly metamorphosed tailed frogs represent the life history stage that migrates farthest away from the stream. Preliminary results from movement studies in the Squamish area found newly metamorphosed tailed frogs 100 m from the nearest stream during the fall (Wahbe et al. 2000). Bury and Corn (1987, 1988) also captured numerous recently metamorphosed tailed frogs in pitfall traps set in forested stands, in the fall.

Habitat

Structural stage

6: mature forest (100–140 years)
7: old forest (>140 years)

Important habitats and habitat features

The presence of intrusive or metamorphic bedrock formations, moderate annual rainfall with a relatively high proportion of it occurring during the summer, and watersheds with low or moderate previous levels of harvest appear to be large-scale regional features in predicting the presence of *Ascaphus* (Wilkins and Peterson 2000).

Terrestrial

Little work has been done on post-metamorphic and adult habitat associations. Coastal Tailed Frogs are more prone to desiccation than most anuran species due to their dependence on vascularized skin for respiration (Claussen 1973b).

Forested riparian areas can benefit tailed frog larvae by moderating stream and ambient temperatures. Forested buffers also help to maintain bank stability and channel characteristics (Kelsey 1995; Dupuis and Friele 1996; Dupuis and Steventon 1999).

Aquatic

The Coastal Tailed Frog inhabits mountain streams with step-pool morphologies, and overall gradients that are not too low or excessively steep (Dupuis et al. 2000). Larvae typically occur in creeks draining basins <50 km^2 but abundance is greatest in basins <10 km^2 (Dupuis and Friele 2003). Step-pools of cool, permanent streams adjacent to old forest with significant understorey are most suitable for this species. The species will also inhabit pool-riffle habitats characteristic of Coast Giant Salamander and fish-bearing streams.

Due to a long larval development period, tadpoles require stable perennial streams. Stable mountain streams are characterized by regularly spaced pools and interlocked cobble/boulder (or wood) steps that withstand moderate floods and sediment pulses (Chin 1998). Creeks composed of coarse substrates (boulders and large cobbles) and granodiorite bedrock that breaks down into coarse rock may maintain a higher density of tadpoles (Dupuis and Friele 1996; Diller and Wallace 1999). Coarse substrates allow for interstitial spaces that can serve as egg-laying and over-wintering sites, and cover in the event of flooding or small bedload movements. This is critical as tailed frogs have been shown to be negatively associated with the amount of fine sediments in streams (Bull and Carter 1996; Welsh and Ollivier 1998; Dupuis and Steventon 1999).

Tadpoles prefer smooth-surfaced substrates with a minimum diameter of 55 mm (Altig and Brodie 1972). Clear water is critical to allow for light penetration which stimulates algal growth, and also to minimize sedimentation which fills the interstitial spaces and results in scouring of periphyton from rocks. Tadpoles prefer rocks in turbulent water, and require interstitial spaces between rocks for both forage and cover (Altig and Brodie 1972). Juveniles and adults forage along the stream channel and in the riparian area and require riparian vegetation, boulders, and coarse woody debris for cover.

The creeks must remain cool throughout the summer as the species has a narrow temperature tolerance. However, at the northern limit of their range cold temperatures (<6°C) are considered limiting. The eggs require temperatures of 5–18°C to survive (Brown 1975). Stream temperatures and food resources during the growing season are probably the most important environmental variables influencing tadpole growth (Brown 1990).

Conservation and Management

Status

The Coastal Tailed Frog is on the provincial *Blue List* in British Columbia. It is designated as a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	CA	OR	WA	Canada	Global
S3S4	S2S3	S3	S4	N3N4	G4

Trends

Population trends

The Coastal Tailed Frog is moderately widespread and locally common. Populations are remarkably discrete within streams. There is no estimated population size for the Coastal Tailed Frog in British Columbia. A recent study showed that Coastal Tailed Frogs occurred in 40–60% of creeks surveyed on the coast of British Columbia, but only 10% near the northern limit of the range (Dupuis et al. 2000).

Habitat trends

Headwater streams have historically been viewed as less important than salmonid streams, and have received little or no protection in British Columbia. Suitable habitat for the Coastal Tailed Frog is declining in British Columbia, particularly in areas that have been clearcut at higher elevations. According to Environment Canada's status report, about 75% of the tailed frog's habitat in British Columbia has been at least partially developed (Environment Canada 2001).

Threats

Population threats

Factors that contribute to the vulnerability of Coastal Tailed Frog populations include its specialized habitat requirements, long larval period, potentially limited dispersal capabilities, low reproductive rates, and low tolerance of warm temperatures. Tadpoles are vulnerable to local extirpations or population declines from massive bedload (boulders, logs, and debris) movements in the creeks. Survival to the adult stage appears to be particularly low in second-growth forests, which are predominant in its range.

Habitat threats

Coastal Tailed Frogs are habitat specialists and occur only in suitable mountain streams. Due to these specialized habitat requirements, the Coastal Tailed Frog is vulnerable to habitat loss and alteration associated with logging. Logging impacts include stream exposure (e.g., Holtby 1988), increased sedimentation (e.g., Beschta 1978; Reid and Dunne 1984), bank erosion (e.g., Beschta 1978), and windfall, as well as reduced summer flow rates and increased peak discharges (Jones and Grant 1996). Sedimentation fills the spaces between rocks, reducing the availability of refuge sites used to escape floods, bedload movements, predation, and warm temperatures. Large-scale habitat disturbance, loss, and fragmentation through road building and timber harvesting are also likely to be detrimental to the species.

Livestock grazing may impact stream habitats where livestock grazing occurs.

Legal Protection and Habitat Conservation

The Coastal Tailed Frog is protected, in that it cannot be killed, collected or held in captivity without special permits, under the provincial *Wildlife Act*. If salmonid habitat exists downstream, some level of protection may be provided through the *Fisheries Act*.

Some populations occur in provincial parks and ecological reserves, such as Cypress Provincial Park, Pinecone Burke Provincial Park, Cathedral Provincial Park, Mount Elphinstone, Garibaldi Provincial Park, and the Kitlope Heritage Conservancy.

The results based code may provide protection through the establishment of old growth management areas (OGMAs), provided these overlap with known sites or suitable habitat. In addition, riparian management guidelines provide a measure of protection for riparian habitats, particularly for streams with game fish. However, since most populations of the Coastal Tailed Frog are found in small streams without fish, they are not protected by FRPA riparian management recommendations. These recommendations do not recommend retention of a riparian reserve zone on small streams where "game" fish are not present. However, they do recommend that forest practices in management zones adjacent to streams classified as S4–S6 (small fish or non fish bearing) be planned and implemented to meet riparian objectives. These objectives can include retaining sufficient vegetation to provide shade, reduce microclimatic changes, maintain bank stability and, where specified, may include objectives for wildlife, fish habitat, channel stability, and downstream water quality.

Finally, some additional protection of Coastal Tailed Frog habitat may come through the creation of special resource management zones (SRMZs) and protected areas for other species, such as the Spotted Owl, and Grizzly Bear.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

In landscapes or portions of landscapes documented to contain tailed frog populations, consider the following recommendations:

❖ Establish OGMAs to protect known tailed frog occurrences and suitable riparian habitats (see "Important habitats and habitat features").

❖ Maximize connectivity of riparian habitats. Wherever possible, increase retention on streams classified as S5 or S6.
❖ Maintain water quality and flow characteristics (i.e., timing and quantity).
❖ Minimize use of chemical applications (e.g., dust-palliative polymer stabilizers and soil binders that can be sprayed within ditch lines).
❖ Avoid cross-stream yarding on suitable streams.

Wildlife habitat area

Goal

Maintain important streams and suitable breeding areas.

Feature

Establish WHAs on important streams and breeding areas. These streams/stream reaches are generally characterized by (1) presence of tadpoles, (2) year-round flow (perennial streams or gullies), (3) intermediate gradient (to allow formation of step-pool morphology), (4) coarse substrates, (5) stable channel beds, and (6) forest cover.

Size

Approximately 20 ha but will depend on site-specific factors including the number and length of stream reach included. Larger WHAs may be appropriate in watersheds with unstable terrain (class IV or V), or when WHAs are established to capture strategic metapopulations.

Design

A WHA should include at least two streams or stream reaches (e.g., S5 or S6) with evidence of presence of tailed frogs. The boundaries of a WHA should be designed to maintain stream conditions (substrate, temperature, macro-invertebrate, and algae communities). The WHA should include a 30 m core area and 20 m management zone on both sides or larger in areas of unstable terrain or to capture strategic metapopulations. Where slopes exceed 60%, the WHA should extend to the top of the inner gorge.

Where several streams with these characteristics occur, priority should be given to sites adjacent to mature or old forest, sites with the greatest potential to establish and maintain mature forest connectivity, sites closest to the headwaters, or sites with high density of tadpoles. In general, WHAs should be established in watersheds with low or moderate levels of historical harvest and on several streams/stream reaches in a drainage to ensure that at least one will maintain a viable subpopulation (Sutherland 2000).

General wildlife measures

Goals

1. Maintain clean and stable cobble/boulder gravel substrates, natural step-pool channel morphology, stream temperatures within tolerance limits.
2. Maintain microclimatic, hydrological, and sedimentation regimes to (1) limit the frequency of occurrence of extreme discharge events, (2) limit the mortality rate of tailed frogs during floods, and (3) meet foraging and dispersal requirements of the adults and metamorphs.
3. Maintain riparian forest.
4. Maintain important structural elements (e.g., coarse woody debris).
5. Maintain water quality and naturally dispersed water flows.
6. Minimize risk of windthrow.

Measures

Access

- Minimize roads or stream crossings within the core area. When roads are determined to be necessary, minimize length and construct narrow roads to minimize site disturbance and reduce groundwater interception in the cutslope; use sediment-control measures in cut-and-fill slopes (e.g., grass-seeding, armouring ditch lines, and culvert outfalls); deactivate roads but minimize digging and disturbance to adjacent roadside habitat; minimize site disturbance during harvesting, especially in terrain polygons with high sediment transfer potential to natal streams; and fall and yard away from, or bridging, all other stream channels (ephemeral or perennial) within the WHA, to reduce channel disturbance and slash loading.

- Where stream crossings are required, ensure the type of crossing structure and any associated roads are designed and installed in a way that minimizes impacts to tailed frog instream and riparian habitats. Use temporary clear span bridges where practicable.

Harvesting and silviculture

- Do not harvest in the core area. Use partial harvesting systems in the management zone that maintain 70% basal area with the appropriate structure necessary to achieve the goals of the GWM.
- Where management zones exceed 20 m, develop a management plan that is consistent with the goals of the GWM.
- No salvage should be carried out.
- Avoid cross-stream yarding.
- Do not use chemical applications (e.g., dust-palliative polymer stabilizers and soil binders that can be sprayed within ditch lines).

Pesticides

- Do not use pesticides.

Range

- Where livestock grazing occurs, follow recommended target conditions for range use in stream riparian areas. Fencing may be required by the statutory decision maker to ahcieve goals.

Additional Management Considerations

Wherever possible and practicable, augment management zone using wildlife tree retention areas.

Manage stream reaches adjacent to WHA according to riparian management recommendations.

Prevent fish introductions and rechannelization of areas supporting tailed frog populations.

Maintain slash-free headwater creeks and forested riparian buffers, especially within fragmented areas.

Information Needs

1. Age-specific movement and dispersal patterns and home range.
2. Demographic responses of Coastal Tailed Frogs to habitat change (e.g., age-class distribution, reproductive success, movement, and dispersal).
3. Opportunity to use variable retention and partial harvesting without degrading habitat suitability.

Cross References

Coastal Giant Salamander, Marbled Murrelet, Pacific Water Shrew

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Great Basin Spadefoot

Spea intermontana

Original prepared by Mike Sarell

Species Information

Taxonomy

The Great Basin Spadefoot, *Spea intermontana,* belongs to the family Pelobatidae (spadefoots) and is the only species in the *Spea* genera in British Columbia. Until recently, the Great Basin Spadefoot was placed in the genus *Scaphiopus*. Although there are no currently recognized subspecies (Green 1999), the variation between populations of *Spea intermontana* may represent separate species (Wiens and Titus 1991).

Description

The Great Basin Spadefoot is the only spadefoot toad in British Columbia. It is a small anuran (40–64 mm svl) that differs from true toads (genus *Bufo*) by having vertical pupils, no (or indistinct) parotid glands, and relatively smooth skin. It has well-developed, sharp-edged black tubercals or "spades" on the bottom of each hind foot, which are used for burrowing. The ventral surface is cream coloured or white whereas the dorsal surface may be olive or grey with spots or streaks. Tadpoles are heavy bodied, grey or tan with brass flecks. Other tadpole characteristics include prominent nostrils close to the eyes, and eyes that are close together and somewhat upturned (Corkran and Thoms 1996).

Distribution

Global

The Great Basin Spadefoot occurs from southern British Columbia, south through the Great Basin to California, Arizona, and east to Colorado and Wyoming (Green 1999). In Canada, it occurs only in British Columbia.

British Columbia

In British Columbia, it occurs in the Okanagan, Similkameen, Kettle, Nicola, and Thompson valleys north to 70 Mile House in the Cariboo, west to Princeton, and east to Grand Forks. In addition to climate, the range of this species is related to the distribution of deep friable soils and wetlands. Their range also may be correlated with the range of pocket gophers (*Thomomys* spp.) and other small mammals due to loosening of compact morainal soils.

Forest region and districts

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Kamloops, Okanagan Shuswap

Ecoprovinces and ecosections

CEI: CAB, CAP*[1], CHP*, FRB*

SIM: SFH*

SOI: NOB, NOH, NTU, OKR, PAR*, SHB, SOB, SOH, STU, THB, TRU

Biogeoclimatic units

BG: xh1, xh2, xh3, xw, xw1, xw2

ESSF: dc*

ICH: dw*, mk*, xw

IDF: dm1, dk1, dk2, mw1*, mw2*, xh1, xh1a, xh2, xh2a, xw

MS: dm*

PP: dh1, xh1, xh2

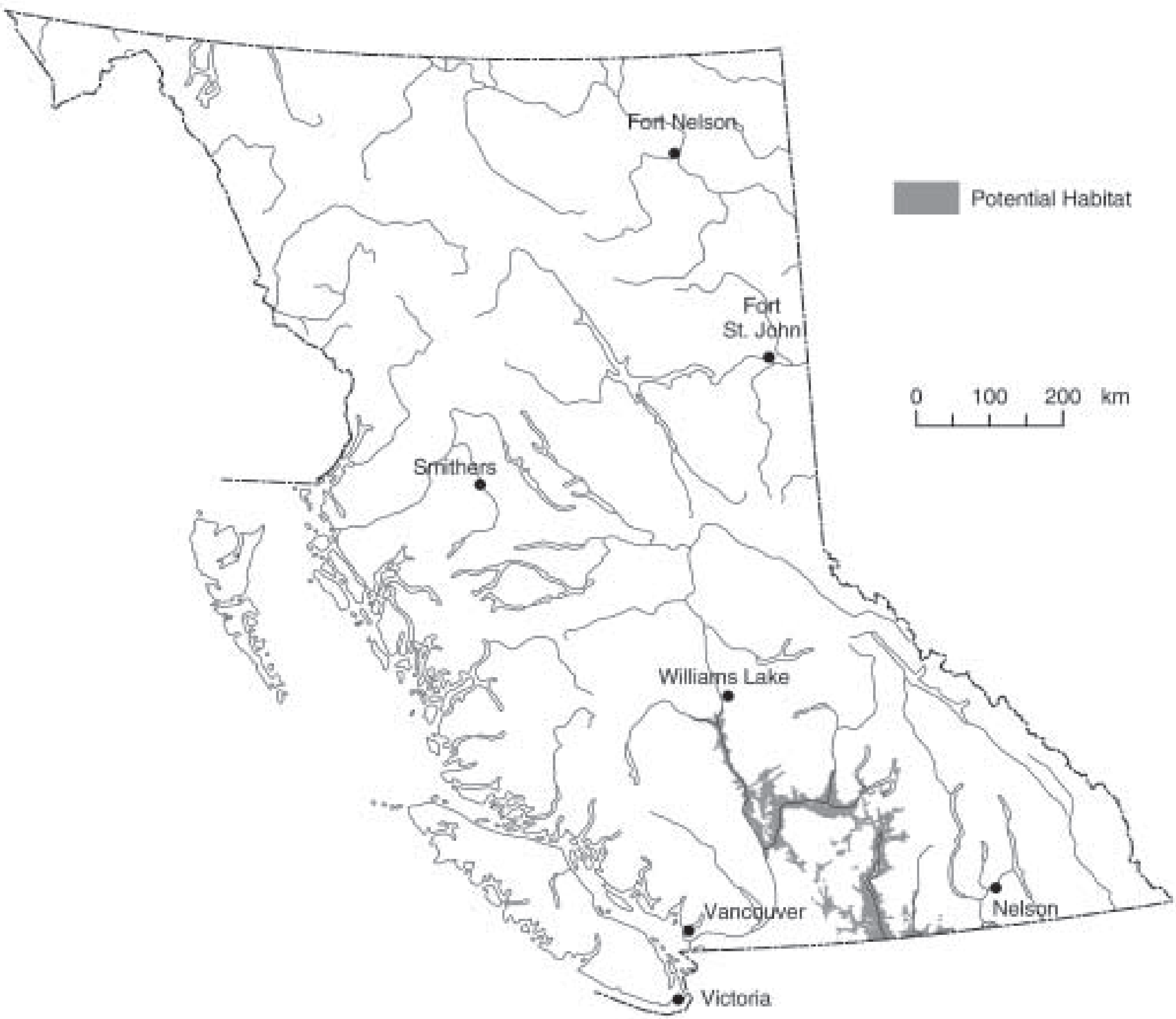
Broad ecosystem units

Terrestrial: AB, BS, DF, DP, OV, PP, SS

Aquatic: GB, LS, SP

1 * Indicates that range extent has not been confirmed.

Great Basin Spadefoot
(Spea intermontana)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Elevation

275–1800 m but generally found breeding below 600 m (St. John 1993; Cannings 1998)

Life History

Diet and foraging behaviour

Adult spadefoots are insectivorous and prey on a variety of invertebrates including earthworms, ants, beetles, crickets, and flies (Nussbaum et al. 1983). Aquatic larvae feed on algae, aquatic plants, or detritus (Green and Campbell 1984). Adult Great Basin Spadefoots forage at night, particularly under warm (>12°C), wet conditions. The remainder of the time is spent inactive, in underground retreats.

Reproduction

The Great Basin Spadefoot reaches sexual maturity at 2–3 years of age. Adults emerge from overwintering sites in mid-April and migrate to aquatic breeding sites. Females deposit eggs from April to early June. Between 300 and 800 eggs are deposited, in clusters of 20–40 eggs, which are fertilized externally. Eggs are normally deposited under the water surface on submerged vegetation or the bottom of pools. Eggs and tadpoles develop relatively rapidly which enables the Great Basin Spadefoot to successfully breed in aquatic habitats that are only available seasonally for short periods before drying up. Tadpoles also exhibit a tolerance to very warm water temperatures (Low 1976). Eggs generally hatch within a week, depending on water temperature, and tadpoles transform in 6–8 weeks. Metamorphosed spadefoots often still have a substantial tail when they leave the water (Nussbaum et al. 1983). The length of the breeding season varies considerably between sites (St. John 1993), but most metamorphosed toadlets appear in July (Cannings 1998).

Site fidelity

Site fidelity to breeding ponds has not been documented. It is assumed that spadefoots will use the nearest available water source, as many breeding sites are ephemeral and not always suitable. It is not known how far spadefoots can successfully travel to a breeding site.

Home range

The distance adult spadefoots will travel from breeding sites has not been documented, and is difficult to determine as some breeding sites are inconspicuous, particularly if they are suitable for breeding only in some years. The nocturnal habits and burrowing nature of the adults also makes it difficult to locate them in foraging areas.

Movements and dispersal

The Great Basin Spadefoot generally migrates to aquatic breeding habitats after the first warm rainfall in the spring. Although information on dispersal distances is lacking, spadefoots may migrate several hundred metres between aquatic breeding sites and terrestrial non-breeding habitats, and some may travel much farther. There are two emigration movements: after adults breed and after young metamorphose.

Habitat

Structural stage

Although most closely associated with herb (2) and shrub (3) structural stages for foraging, they will occur in open forest (4–7). Soil texture and depth, and an open habitat structure are more critical factors in determining foraging suitability.

Important habitats and habitat features

Aquatic

The Great Basin Spadefoot breeds in permanent or temporary aquatic habitats such as lakes, seasonal wetlands, rain pools, flooded areas along streams, and pools in intermittent streams. Shallow water is an important feature of suitable breeding sites, including the edges of deeper water features. Emergent vegetation aids in breeding as a substrate for egg deposition but is not essential. The absence of predatory fish dramatically increases the survival of eggs and tadpoles. Breeding habitat is used between April and July.

Terrestrial

Spadefoots occur in semi-arid habitats such as bunchgrass grasslands, sagebrush steppe, and open ponderosa pine (*Pinus ponderosa*) forests. They escape dry conditions by retreating into underground refuges such as small mammal burrows or by burrowing into the soil. Loose and deep soils provide suitable burrowing habitat. They may also retreat under coarse woody materials. It is unknown how deep the burrows must be to avoid lethal temperatures during winter hibernation, but may be up to 1 m or more. Terrestrial habitats are used throughout the year.

Conservation and Management

Status

The Great Basin Spadefoot is on the provincial *Blue List* in British Columbia. It is considered *Threatened* in Canada (COSEWIC 2002).

Summary of status in British Columbia and adjacent jurisdictions (NatureServe Explorer 2002)

BC	CA	CO	ID	MT	WA	Canada	Global
S3	S5	S3	S4	SR	S5	N3	G5

Trends

Population trends

Only three detailed population surveys have been conducted in British Columbia (St. John 1993; Leupin et al. 1994; Weber 1996), all in the south Okanagan or Thompson and Nicola valleys. The population is estimated to be approximately 10 000 (Cannings 1998); however, trends are not known (Cannings et al. 1999). The population in British Columbia has been described as "clumped" because over half of the calling males are reported from only three sites (Cannings 1998). The largest populations in the Okanagan are at Osoyoos Oxbows and Osoyoos Effluent Lagoon (St. John 1993).

Habitat trends

Most of the spadefoot population occurs in the arid grasslands in the valley bottoms of the Okanagan, Similkameen, Kettle, Nicola, and Thompson watersheds. These habitats, especially the Okanagan, are under intense development pressure. It was estimated that <9% of the south Okanagan remains in a relatively natural state (Redpath 1990). Agricultural and residential developments have already altered much of their former habitat. Most of the remaining habitats throughout their range are roaded or used for grazing, and much is weeded.

The largest known population of Great Basin Spadefoot occurs at the Osoyoos sewage lagoon (St. John 1993), where much of the surrounding antelope-brush and sagebrush grasslands have been recently lost to housing and golf course expansion.

Threats

Population threats

The range of the Great Basin Spadefoot in British Columbia tends to be concentrated in the valley bottoms, where the demand for agricultural and residential land is high. Because the distribution appears to be clumped, populations may be more susceptible to local extirpation if these areas are disturbed.

There are no known disease or infection threats, although at least one die-off of Tiger Salamanders (*Ambystoma tigrinum*) has occurred in the south Okanagan, for unknown reasons. These species are sympatric in breeding habitats within the salamander's range.

The water table at many sites within the range of the Great Basin Spadefoot has dropped significantly in the past decades, due to reduced precipitation and possibly increased human consumption (Cannings 1998). Although spadefoot eggs and tadpoles develop quickly, shorter breeding periods due to drying ponds likely reduce breeding success, and may prevent it altogether in dry years. If permanent or ephemeral breeding sites were to dry up, spadefoots would become increasingly dependent on fish-bearing and artificial or managed water bodies.

In permanent water bodies, non-native species, especially various species of non-native predatory fish, are a threat. Bullfrogs (*Rana catesbeiana*) have not successfully colonized spadefoot breeding habitat yet but have been the cause of significant declines elsewhere. In terrestrial habitats, the invasion of non-native plants may affect the available invertebrate composition and may hinder burrowing due to continuous root mats.

Although nothing is known about the specific effect on Great Basin Spadefoots, amphibians are known to be highly susceptible to environmental contaminants and changes (Seburn and Seburn 2000). Water quality of breeding sites may be affected by pollution from pesticides, dumping refuse to fill wetlands, and runoff from accumulated livestock faeces.

High mortality from road kill occurs at some migration areas. Traffic statistics in the south Okanagan range from an average of 2–14 cars per minute at various locations on Highway 97 during the summer (MOTH 1999).

Habitat threats

The primary threat to the Great Basin Spadefoot in British Columbia is likely habitat loss and fragmentation due to urban and agricultural development, for both breeding sites and foraging areas.

Livestock grazing can negatively impact Great Basin Spadefoot habitats due to soil and burrow compaction, trampling, loss of cover (riparian and grassland vegetation), and reduced water quality (Leupin et al. 1994; Cannings 1998; M. Sarell, pers. obs.). Leupin et al. (1994) found that nearly of all the surveyed ponds with spadefoot toads showed signs of livestock impact at the pond edge. Livestock may also create small depressions (hoof prints) that may trap developing eggs or larvae and which readily dry out, stranding the eggs or larvae.

Stocking lakes with sport fish may increase predation on spadefoot eggs and tadpoles. Loss of grasslands to recreational facilities such as golf courses reduces available foraging habitat. Off-road vehicles can cause disturbance to both grasslands and wetland edges. In grasslands, motor vehicles may cause soil compaction or erosion. At wetlands, vegetation and soil disturbance is largest when water levels are low and much of the foreshore is exposed, allowing access to a large area of mudflats. The resulting deep ruts may trap eggs or tadpoles as the pond dries.

Water management may benefit spadefoots by creating reservoirs, providing dependable breeding habitats in otherwise dry areas (Nussbaum 1983). Alternately, irrigation projects may decrease the availability of foraging areas through conversion to agricultural crops (Cannings 1998) and reduce the depth and duration of standing water. Further, irrigation may attract spadefoots to areas that are unsuitable for breeding, thus losing breeding opportunities for the season, due to the false appearance of available water.

Legal Protection and Habitat Conservation

The Great Basin Spadefoot is protected in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act*. The species is listed as Threatened under COSEWIC, and may be afforded some level of federal protection pending proposed legislation.

Two of the three largest populations are protected or partially protected by the Haynes Lease Ecological Reserve (100 ha), South Okanagan Wildlife Management Area, and Lac du Bois Provincial Park. The Nature Trust of BC owns lands that support smaller breeding populations of spadefoots. Other areas where they occur have recently been protected by the creation of White Lake Grasslands and South Okanagan Grasslands provincial parks.

Until the recent designation of the two grassland parks, only 6% (4600 ha) of suitable Great Basin Spadefoot habitat in the south Okanagan was designated as conservation lands, and 26% (~15 000 ha) was found on Crown land. Approximately 68% (about 40 000 ha) of suitable habitat is on Indian Reserves or private land (MELP 1998).

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Protect, and maximize connectivity between, known or suitable aquatic breeding sites and terrestrial non-breeding habitats (i.e., foraging and overwintering habitats). Identify potential and known ephemeral and cyclical aquatic breeding habitat.

Wildlife habitat area

Goal

Maintain suitable aquatic breeding habitats and integrity of adjacent terrestrial non-breeding habitat.

Feature

Establish WHAs at known breeding areas.

Size

Approximately 10 ha but will depend on site-specific factors such as size of water feature and extent of surrounding suitable habitat.

Design

The WHA should include a core area and may include a management zone. The core area should include the aquatic breeding site(s) and suitable uplands within ~250 m to protect most of the aestivation habitat. A management zone may be included to capture high quality habitat or to provide connectivity between populations.

General wildlife measures

Goals

1. Minimize disturbance during the breeding season.
2. Minimize road mortality.
3. Maintain water quality.
4. Maintain water levels.
5. Minimize soil disturbance and trampling of burrows.
6. Maintain important habitat features (i.e., small mammal burrows, riparian and emergent vegetation, and non-compacted soils).
7. Maintain or remediate riparian and aquatic habitats to a properly functioning condition.

Measures

Access

- As recommended by MWLAP, do not construct roads, deactivate temporary road structures, and close roads during critical times. Drift fences and culverts may be recommended by the statutory decision maker for locations where road mortality is extensive.
- Do not construct roads, although skidder trails may be acceptable on drier sites or in the winter.
- Do not place landings within core or management zone.

Harvesting and silviculture

- Do not harvest within core area.
- Minimize ground disturbances and do not scarify harvested areas.
- Stock only to natural densities, maintaining open forest characteristics with clearings, as per an NTD4 fire maintained ecosystem.

Pesticides

- Do not use pesticides.

Range

- Plan livestock use in the core area to meet objectives described above (GWM goals). Exclusion fencing may be required by the statutory decision maker to meet objectives.
- Do not place livestock attractants within WHA.

Additional Management Considerations

Maintain water levels and avoid draining wetland habitats.

Maintain ephemeral water features.

Prevent fish introductions in permanent water bodies.

Prevent incompatible recreation activities and prevent off-road vehicle access.

Encourage private land stewardship where important habitat extends beyond Crown land.

Information Needs

1. Distribution, both inside and outside of known range.
2. Limiting habitat (aquatic and terrestrial) and factors.
3. Movement and dispersal patterns.

Cross References

Badger, Burrowing Owl, Fringed Myotis, Grasshopper Sparrow, "Great Basin" Gopher Snake, Racer, "Sagebrush" Brewer's Sparrow, Sage Thrasher, Tiger Salamander, Western Rattlesnake

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Northern Leopard Frog

Rana pipiens

Original prepared by I.A. (Penny) Ohanjanian and Kathy Paige

Species Information

Taxonomy

The Northern Leopard Frog belongs to the family Ranidae (true frogs) and the genus *Rana*. No subspecies are currently recognized (Green 1999).

Description

The Northern Leopard Frog is a medium-sized (50–100 mm snout-vent-length [svl]), semi-terrestrial frog. Distinguishing characteristics include two conspicuous cream-coloured dorsolateral folds that extend the length of the back and large, distinct, solid dark brown or olive spots with smooth pale borders on head, back, sides, and legs (Green and Campbell 1984); legs are long, and webbing does not extend to tips of toes. Typically the dorsal surface is green or brown and the ventral surface is white. Tadpoles are ~25 mm svl, dark brown and speckled with gold spots. The eyes are bronze-coloured. The height of the dorsal fin is equal to or less than the thickness of tail trunk at its base. See detailed description in Corkran and Thoms (1996).

Distribution

Global

The Northern Leopard Frog is part of a group of anurans (the Leopard Frog complex) that is widely distributed throughout North America. In Canada, populations exist from southeastern British Columbia east to the Maritimes, while in the United States, the species ranges south to California and New Mexico and east to South Carolina (Stebbins and Cohen 1995). In parts of the mid-West and western portions of its range, however, populations of Northern Leopard Frog have disappeared or declined significantly (Hine et al. 1981; Roberts 1992; Seburn 1992; Corn and Fogleman 1994; McAllister et al. 1999).

British Columbia

In British Columbia, the Northern Leopard Frog historically occurred in the Kootenay and Columbia River valleys and in the Rocky Mountains east of Fernie near Corbin (Seburn and Seburn 1998). The species was also reported from Osoyoos Lake in the Okanagan Valley (Carl 1949). The most northerly location was Bush Arm, 70 km north of Golden, with other sightings in marshes and ponds along the Columbia and Kootenay River systems from Golden south to Newgate near the U.S. border (Seburn and Seburn 1998). None have since been recorded at these locations although surveys were carried out in the late 1990s (Ohanjanian and Teske 1996; Gillies and Franken 1999). Today the Northern Leopard Frog is known from only one site in the Creston Valley Wildlife Management Area (Ohanjanian 1997; Waye and Cooper 1999). An population which is believed to have been introduced in the 1930s (Green 1978) was found at Parksville (Hamilton Marsh) on Vancouver Island in 1976. The current status of this population is not known (L. Friis, pers. comm.).

Forest region and districts

Coast: South Island (introduced)

Southern Interior: Columbia, Kootenay Lake (extant), Okanagan Shuswap (Penticton – historic), Rocky Mountain

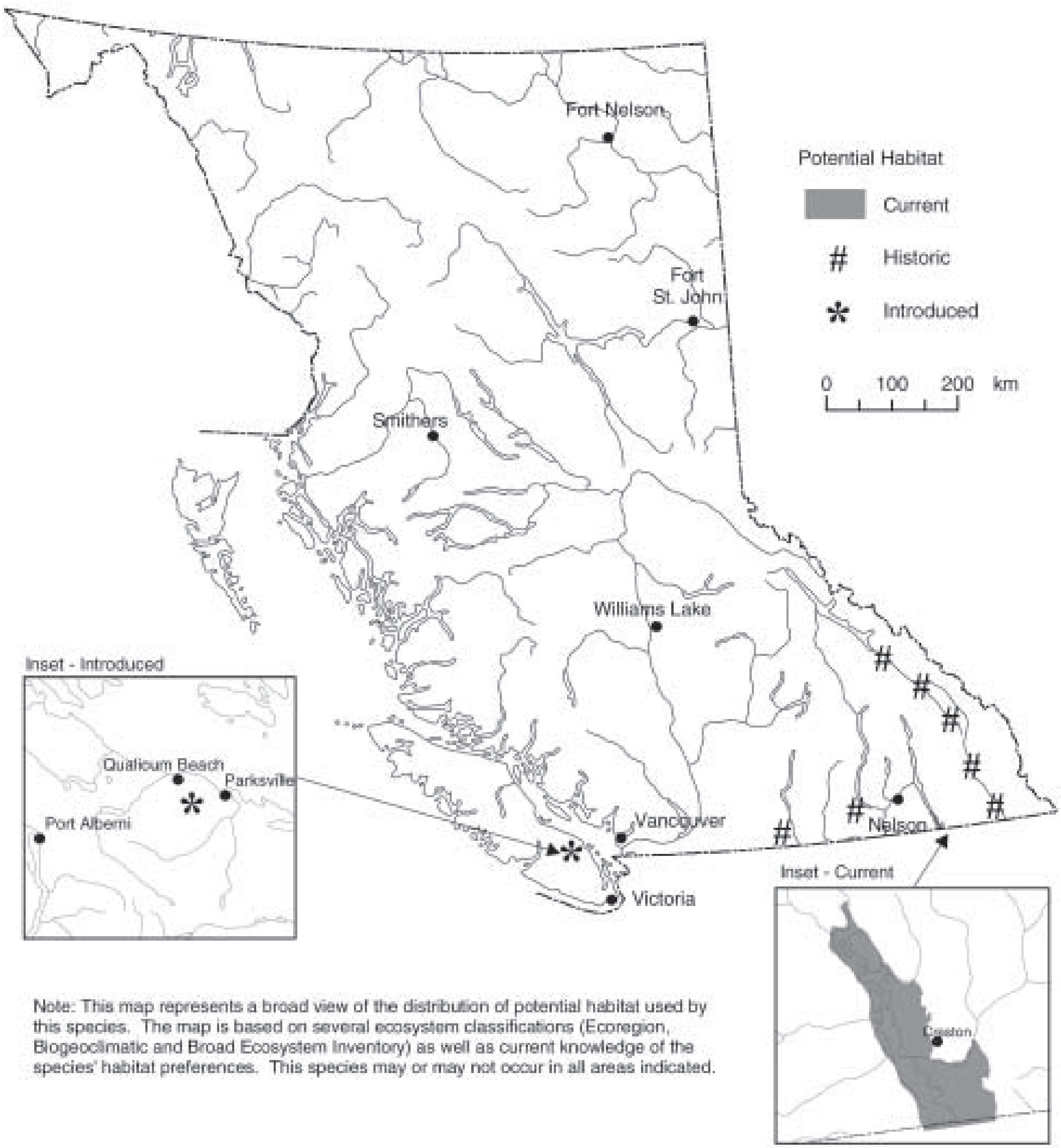
Ecoprovinces and ecosections

GED: NAL (introduced)

SIM: EKT (historic), FLV (historic), SCM (current), UCV (historic)

SOI: NOB (historic), OKR (historic), SOB (historic)

Northern Leopard Frog
(Rana pipens)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Biogeoclimatic units

BG: xh1 (historic)
CDF: mm (introduced)
ICH: xw (current)
ICH: dw, mk1 (historic), mw2
IDF: dm2 (historic)
MS: dk (historic)
PP: xh1 (historic)

Broad ecosystem units

CF, CR, LS, OW, RR, WL, WR

Elevation

82–1400 m

Life History

Diet and foraging behaviour

The Northern Leopard Frog is an opportunistic forager. Its diet consists of a variety of prey including insects, arachnids, worms, crustaceans, and other small vertebrate prey (McAllister et al. 1999). Adults and juveniles forage primarily on land. Tadpoles graze on phytoplankton, algae, periphyton, and detritus.

Reproduction

Sexual maturity is most commonly reached in 2 years, but this may vary from 1 to 3 years. Generally, courtship begins in mid-April after adult frogs have left overwintering habitat and arrived at breeding sites. Males congregate in the shallow waters at breeding sites and begin calling in mid-April. This may last until June (Waye and Cooper 1999). The time of egg deposition varies with latitude and elevation (Fichter and Linder 1964), and in British Columbia this occurs most often in April and May (Orchard 1984; Waye and Cooper 1999). Females deposit a single egg mass, which may contain between 600 and 7000 eggs (Corn and Livo 1989). Females tend to deposit egg masses close to each other, where two to several dozen egg masses may occur over a small area (Nussbaum et al. 1983; Wright and Wright 1995). Egg masses are attached to submerged vegetation in shallow water but may occasionally be deposited on the surface (Hine et al. 1981; Corkran and Thoms (1996). A variety of plant species are used, including sedges (*Carex* spp.), bullrushes (*Scirpus* spp.) (Hine et al. 1981; Corn and Livo 1989), cattails, twigs, or even grass (Wright and Wright 1995). In British Columbia, spikerush (*Eleocharis palustris*) is used (Waye 2000). Eggs hatch within 9 days and metamorphosis can occur in as little as 2 months (68.2–86.0 days; Corn 1981). Metamorphosis occurs in July and August (Orchard 1984; Waye and Cooper 1999). A number of environmental factors, including water temperature, can influence development rates at all stages.

Site fidelity

Northern Leopard Frogs appear to exhibit strong site fidelity to breeding and overwintering sites (Waye and Cooper 1999; T. Antifeau, pers. comm.), while greater flexibility is probable with respect to foraging areas (M.A. Beaucher, pers. comm.).

Home range

Adults maintain small home ranges ranging from 15 to 600 m^2 (Dole 1965). Radio-telemetry work suggests that frogs prefer to spend long periods at the edge of water bodies (Waye and Cooper 1999).

Movements and dispersal

Movements can occur at night or during the day (Merrell 1977; Seburn et al. 1997). Generally, adult Northern Leopard Frogs do not move very far (i.e., 5–10 m but occasionally 100 m) (Doyle 1965). Waye (2000) found that radio-tagged leopard frogs would not move for several days, then move 5–50 m away but return to their original location. On a seasonal basis, leopard frogs move greater distances. Northern Leopard Frogs move from overwintering sites in April to breeding ponds. The distance between breeding and overwintering locations can be a few metres or up to several kilometres (Merrell 1977). If breeding sites are ephemeral, the frogs will move, after breeding, to more permanent wetlands for the remainder of the summer (Nussbaum et al. 1983; Cannings et al. 1999). Metamorphs typically remain within 20 m of shoreline although some disperse before metamorphosis is complete. Metamorphs dispersing from natal sites generally disperse within a couple of kilometres but have been recorded to disperse up to 8 km from natal sites (Seburn et al. 1997) and can move up to 800 m a night (Dole 1971). Migration back to overwintering sites may begin as early as August (M.A. Beaucher, pers. comm.) with the bulk of the movement occurring in September and October.

Habitat

Structural stage

2a–d: herb
3a: low shrub

Important habitats and habitat features

Aquatic

Aquatic habitats are needed for breeding and overwintering. The Northern Leopard Frog breeds in a variety of temporary and permanent aquatic habitats. Shallow water depths, abundant emergent vegetation, and absence of predatory fish species are important characteristics of most successful breeding sites (Merrell 1977; Leonard et al. 1993). Temporary aquatic habitats that hold water until late July or August or permanent ponds will reduce the risk that eggs or larvae may die as water levels drop. On the other hand, wetlands that dry up every few years prevent the establishment of fish populations. In Minnesota, preferred aquatic habitats were temporary ponds with a water depth of 1.5–2 m where fish were absent (Merrell 1968). In British Columbia, however, leopard frogs use wetland areas with shallow (20–30 cm), open water and beds of spikerush for breeding (Waye and Cooper 1999).

Deeper water that does not freeze to the bottom is required for overwintering sites. Northern Leopard Frogs typically spend the winter on the bottom of wetlands or streams often in organic debris or leaf litter, or under logs. Overwintering habitats must also maintain sufficient oxygen to prevent the water from becoming anoxic (Merrell 1977; Cunjak 1986).

Terrestrial

Terrestrial habitats are important for foraging and dispersal. This species forages in moist terrestrial environments, typically riparian habitats, but may move farther during wet periods. Although it may forage in a variety of terrestrial habitats, habitats with short (15–30 cm tall) vegetation appear to be preferred and tall (>1 m) grass areas are avoided, as are wooded areas, open areas, and heavily grazed or mowed areas (Merrell 1977).

Riparian habitat may be important, particularly in drier environments, for dispersal (Seburn et al. 1997).

Conservation and Management

Status

The Northern Leopard Frog is on the provincial *Red List* in British Columbia. In Canada, the southern mountain population is designated as *Endangered* (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

The Northern Leopard Frog has undergone a significant and widespread population decline in the last 20 years in western Canada and the United States (Bishop and Pettit 1992; Seburn and Seburn 1998). In British Columbia, only one extant site remains and the current estimated population is 1000 adults (Waye and Cooper 1999).There are at least 12 historic sites (Waye 2000). These records indicate a much wider distribution and abundance in the 1940s through 1970s than has been observed since that time. In the 1970s the species was described as

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	BC	CA	ID	MT	OR	WA	Canada	Global
S2S3	S1	S2	S3	S3S4	S2?	S1	N5	G5

being numerous in the Creston area but by the early 1980s it was considered uncommon (Ohanjanian 1996). Surveys conducted from 1988 to 1990 (Orchard 1992) and 1995 (Ohanjanian and Teske 1996) were largely unsuccessful at locating leopard frogs. Northern Leopard Frogs have only been consistently reported, although in relatively low numbers (4 in 1991, 7 in 1996, 37 in 1997, 116 in 1998, 150 in 1999), from one area (i.e., Creston Wildlife Management Area) (Orchard 1992; Ohanjanian 1996; Waye 2000).

Significant declines have also been experienced in jurisdictions adjacent to British Columbia including Alberta, Idaho, Montana, and Washington. In Washington, the Northern Leopard Frog was historically known from eight counties but is currently only known from one (McAllister et al. 1999). Populations in southern and central Alberta have also declined dramatically (Roberts 1992; Wagner 1997), and in southern Idaho (Koch et al. 1996) and Montana (Reichel et al. 1996).

Habitat trends

Within the historic range of the Northern Leopard Frog, land use changes have resulted in the loss and alteration of some aquatic and riparian habitats. This is particularly true of Osoyoos Lake, which has seen increased urbanization and agricultural development since the late 1940s. The flooding of the Kinbasket Reservoir has altered habitat in the Bush Arm area. Much of the Columbia Marshes, however, have remained relatively unchanged. In the Creston Valley Wildlife Management Area (CVWMA), approximately 4500 ha of 6970 ha have been dyked (Frazier 1996). Dyking at the CVWMA created permanent ponds which tend to favour predatory fish populations and probably created barriers to seasonal frog movements. These negative effects may have been partially offset by the creation in some areas of relatively stable water levels and development of submergent and emergent plant communities in areas that had previously been exposed mud flats.

Threats

Population threats

There is only one extant site remaining in British Columbia (Cannings et al. 1999) which makes this species vulnerable to extirpation.

Non-native predatory fish, such as bass (*Micropterus* spp.), black bullhead (*Ameiurus melas*), and sunfish (*Lepomis* spp.), may displace and prey on native frog eggs, tadpoles, and metamorphs (Orchard 1992; Hayes and Jennings 1986). The introduction of predatory fish and bullfrogs into habitats occupied by Northern Leopard Frogs has contributed to the decline of leopard frogs in Washington (McAllister et al. 1999) and California (Hayes and Jennings 1986), and have been found to negatively impact Northern Leopard Frogs in Ontario (Hecnar and M'Closkey 1997). In addition, introduced plant species, such as purple loosestrife, can also alter wetland habitats making them less suitable or increasing the rate of eutrophication.

The role of infectious agents in amphibian declines and their interaction with stressed immune systems is currently under intense study. Diseases, such as Red-leg disease (a common bacterial infection in amphibians and fish), is believed to be implicated in a die-off of Northern Leopard Frogs in the 1970s (Bishop and Pettit 1992). Chytridiomycosis and other fungi have been shown to cause mortality associated with amphibian declines (Blaustein et al. 1994b; Berger et al. 1998) around the world. Ranaviruses too could be having an impact on herpetofauna globally, and may be contributing to the observed decline in amphibian numbers in some areas (Cullen and Owens 2000).

Numerous chemical applications are used in urban and agricultural environments. Fertilizer (ammonium nitrate) has been found to be toxic to Northern Leopard Frogs (Hecnar 1995), and larval amphibians are vulnerable to low levels of pesticides (Berrill et al. 1997). Possible effects on amphibian populations may be lowered reproductive capacity, deformities, and reduced ability to avoid predators.

In dry years, temporary aquatic habitats may be less available or dry up earlier resulting in reduced reproductive success and increased mortality (Hine et al. 1981). Drought, which can result in breeding habitats drying up, has been suggested as contributing to the disappearance of Northern Leopard Frogs in the Rocky Mountains (Corn and Fogleman 1984), but this does not appear to have been the case in British Columbia. The long-term local effects of global climate change in the Columbia basin are not known.

Increased UV-B radiation has been shown to affect developing amphibian embryos (Blaustein et al. 1994a); the degree to which this may be naturally offset by environmental factors (such as dissolved organic matter) is currently under study.

Historically this species was commercially collected in large numbers for scientific and educational studies.

Habitat threats

The loss, fragmentation, and alteration of wetland habitat is the primary threat to habitats of the Northern Leopard Frog.

Livestock grazing may impact leopard frog populations through the loss or alteration of riparian vegetation and habitats. In addition, cattle can trample egg masses in shallow waters. Livestock defecation within aquatic or riparian habitats may also alter water conditions. Northern Leopard Frogs rarely occur in heavily grazed areas (Merrell 1977).

Conversion of wetlands into croplands, such as hay or grain, has a negative impact. Not only is wetland habitat lost, but terrestrial foraging may be hampered by thick stands of alfalfa or cereal crops.

Urban development usually results in the draining of wetlands, the dumping of road wastes into wetlands, and destruction of riparian zones. Even if the wetlands *per se* are maintained, roads that are constructed between breeding, foraging, and/or overwintering habitats results in increased road mortality during seasonal migrations (Merrell 1977).

Alterations to hydrological regimes brought about by channelling, dyking, irrigating, and draining can have severe impacts on Northern Leopard Frogs. Overuse of aquifers by domestic wells and irrigation can lower the water table and reduce the occurrence of temporary wetlands (Corn and Fogleman 1984). Streamside aquatic vegetation may be affected by channelling, which in turn may affect both the prey base and the quantity of cover available. Hydrological changes can result in lower available dissolved oxygen in wintering sites, a factor that is crucial for overwintering survival (Cunjak 1986). Canals and ditches may connect previously isolated wetlands to those with predatory fish populations. Conversely, dyking may strand tadpoles in areas where water levels dry out (Wagner 1997) and steep slopes may impede movements of metamorphs and adults.

Legal Protection and Habitat Conservation

The Northern Leopard Frog is protected, in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act*.

Northern Leopard Frogs require the protection of aquatic breeding and overwintering habitat and terrestrial foraging habitat.

The only extant site remaining in British Columbia is within the Creston Valley Wildlife Management Area (6970 ha). The Creston Valley is listed by the International Convention on Wetland Protection as a wetland of international importance (Frazier 1996). Suitable habitat is also included within the Columbia National Wildlife Area (Cannings et al. 1999). Approximately 82 720 ha of wetland habitat is included within National Wildlife Areas, Wildlife Management Areas, and other unofficial areas managed for wildlife in the Columbia Valley. However some industrial and recreational activities are permitted within these areas.

Under the results based code (RBC), riparian buffers are required on lakes, wetlands, and streams.

However, small non-classified wetlands and small fishless streams do not receive any protection. The most critical components for terrestrial habitat are sufficient cover and, on a larger scale, connectivity between wetlands and overwintering sites to maintain metapopulation dynamics in the landscape. Connectivity of habitats is not explicitly addressed under the RBC but may occur through landscape level planning.

The Northern Leopard Frog Recovery Team is currently developing recommendations for reintroducing populations into suitable habitat. The intent is to establish five viable populations of Northern Leopard Frog within 10 years in the Kootenay, Columbia, and Creston valleys. In 2001and 2002, 480 and 2300 metamorphs, respectively, were reintroduced into another area of the CVWMA (M.A. Beaucher, pers. comm.).

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain suitable habitat for reintroduction of Northern Leopard Frogs.

Feature

Establish WHAs at suitable sites as determined by the provincial recovery team or action group. The WHA should encompass all necessary attributes including aquatic breeding habitat, terrestrial foraging habitat, and overwintering habitat.

Size

Based on research on the only extant population in British Columbia, a WHA that is 1 × 2 km is recommended.

Design

The WHA should include a wetland breeding site, adjacent terrestrial foraging habitat, and an overwintering site. This last feature should be within 1.7 km of the breeding/foraging habitat, and <800 m where possible. The WHA should generally include a 50 m management zone surrounding the habitat features of the WHA (wetland, riparian habitats, overwintering site). When selecting and designing the boundaries of the WHA, maintain or restore connectivity between the aquatic-breeding habitat, terrestrial foraging habitat, and overwintering sites (if different than breeding site). The establishment of a metapopulation structure over more than one locale may be assisted if streams are present to facilitate movement and colonization (Seburn et al. 1997).

General wildlife measure

Goals

1. Maintain structural integrity and abundance of submergent and emergent vegetation (i.e., spikerush) to provide egg-laying sites and rearing habitat for developing tadpoles.
2. Maintain riparian vegetation to provide cover, but manage sites to reduce abundance of overly thick reed canary grass stands that would impede movement. Good cover to lower predation during seasonal migration is beneficial.
3. Maintain water quality and water levels.
4. Maintain WHA in a properly functioning condition.
5. Prevent or reduce road mortality.

Measures

Access

- Do not construct roads, deactivate temporary road structures, and close roads during critical times as recommended by MWLAP. Barrier fences may be recommended by the statutory decision maker for locations where road mortality is extensive.

Pesticides

- Do not use pesticides.

Range

- Plan livestock use in the core area to meet objectives described above (GWM goals). Exclusion fencing may be required by the statutory decision maker to meet objectives.
- Do not place livestock attractants within WHA.

Additional Management Considerations

Minimize road mortality by avoiding road developments that intersect known dispersal routes or incorporating barrier fences and "toad tunnels" to enable the safe passage of frogs.

Prevent introduction of fish species into suitable habitats for Northern Leopard Frogs.

Prevent or minimize wetland drainage, dyking, or flooding.

Information Needs

1. Suitability of proposed release sites must be assessed and compared with known areas of occupation.
2. Knowledge of the genetic structure of populations in British Columbia, Washington, Idaho, and Montana would be useful in deciding source populations for release sites.
3. Further study of the cause(s) of the Northern Leopard Frog decline in the west may provide information on the suitability of potential release sites.

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Rocky Mountain Tailed Frog

Ascaphus montanus

Original prepared by Linda A. Dupuis

Species Information

Taxonomy

Phylogenetic studies have determined that tailed frogs belong in their own monotypic family, Ascaphidae (Green et al. 1989; Jamieson et al. 1993). Recent phylogeographic analysis has determined that coastal and inland assemblages of the tailed frog are sufficiently divergent to warrant designation as two distinct species: *Ascaphus truei* and *Ascaphus montanus* (Nielson et al. 2001). The divergence of coastal and inland populations is likely attributable to isolation in refugia in response to the rise of the Cascade Mountains during the late Miocene to early Pliocene (Nielson et al. 2001).

The Coastal Tailed Frog and Rocky Mountain Tailed Frog are the only members of the family Ascaphidae and are considered the most primitive frogs in the world, representing the basal lineage of the anurans (Ritland et al. 2000; Nielson et al. 2001).

Description

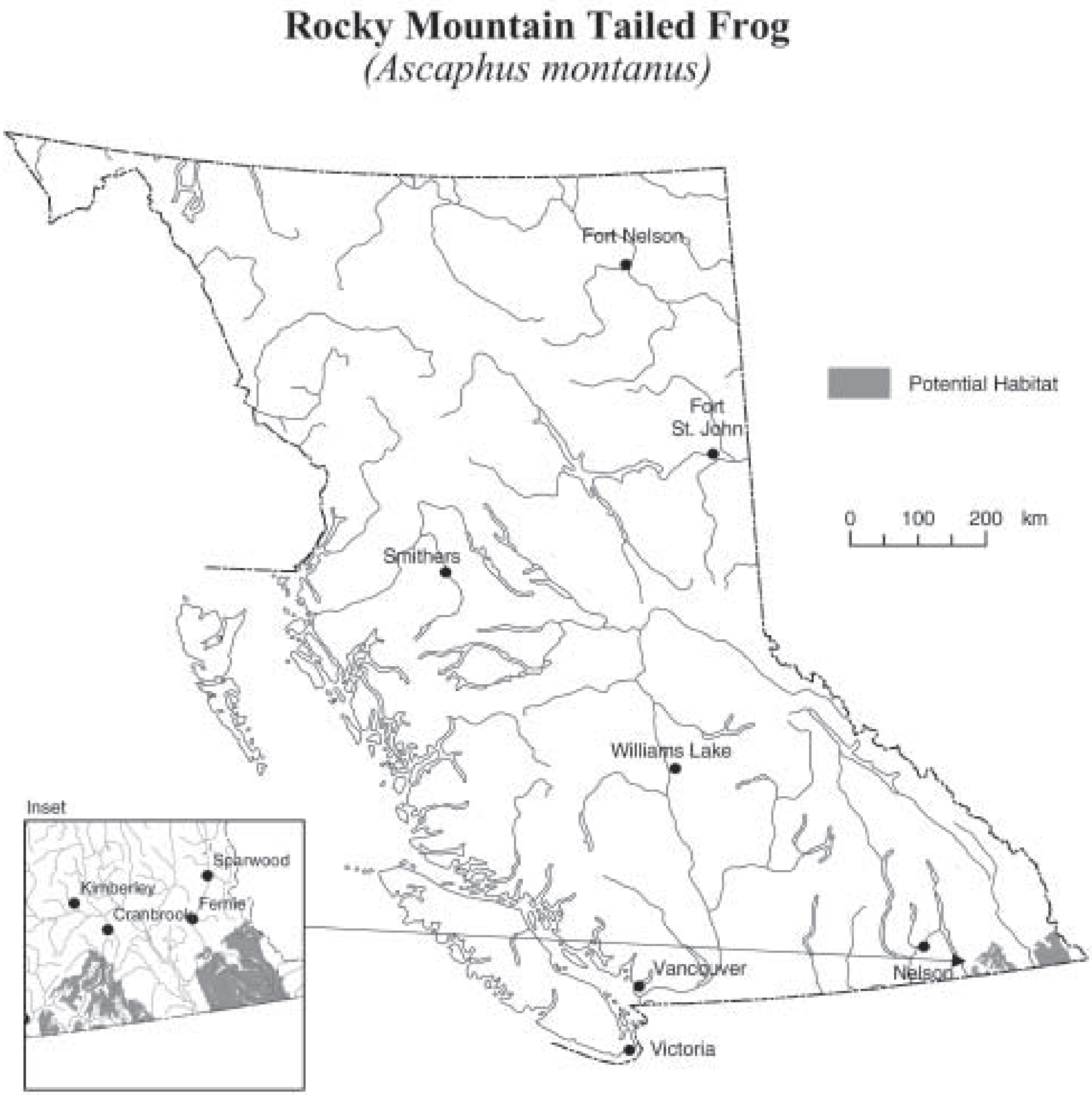
Tailed frogs have unique morphological adaptations to life in fast-flowing mountain streams. They are the only frog species in North America that breed in cold mountain streams. Adults are small (2.2–5.1 cm) with a large head, a vertical pupil, and broad and flattened outer hind toes. They lack tympana (ear membranes) and the ability to vocalize, presumably adaptations to the constant sound of rushing water. The species is commonly known as the Tailed Frog because males have a short, conical "tail" with which to inseminate females. Adults have a grainy skin that can vary in colour from tan, to chocolate brown, to olive green (Metter 1964a; Dupuis, pers. obs.); fine black speckling generally occurs on paler individuals. There is often a distinct copper bar or triangle between the eyes and snout, with green undertones (Metter 1964a).

Tadpoles are roughly 11 mm in length upon hatching, and can reach up to 65 mm long prior to metamorphosis (Brown 1990). They possess a wide flattened oral disc modified into a suction mouth for clinging to rocks in swift currents and grazing periphyton (Metter 1964a, 1967; Nussbaum et al. 1983), a ventrally flattened body, and a laterally compressed tail bordered by a low dorsal fin. They are black or light brownish-grey, often with fine black speckling; lighter flecks may or may not be present (Dupuis, pers. obs.). The tadpoles usually possess a white dot (ocellus) on the tip of the tail and often have a distinct copper-coloured bar or triangle between the eyes and snout. Hatchlings lack pigmentation, and are most easily characterized by the large, conspicuous yolk sac in the abdomen.

Distribution

Global

The Rocky Mountain Tailed Frog is endemic to the Pacific Northwest and occurs in the Blue Mountains of southeast Washington (Metter 1964a; Pauken and Metter 1971; Bull 1994), the Wallowa Mountains of northeast Oregon (Ferguson 1952; Bull and Carter 1996), central Idaho and the panhandle (Linsdale 1933; Corbit 1960; Maughan et al. 1980), the Columbia Ranges and Rocky Mountain Foothills of southeastern British Columbia (Dupuis and Wilson 1999), and the mountains east of western Montana's Bitterroot Ranges (Smith 1932; Franz and Lee 1970). Historically, at least one population was found on the eastern slopes of the Rocky Mountains (Donaldson 1934).



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

British Columbia

The Rocky Mountain Tailed Frog was first identified in the Southern Interior Mountains Ecoprovince in 1958 (Grant 1961). This occurrence was confirmed in the 1980s, but no official surveys were conducted until 1996 (Dupuis and Bunnell 1997; Dupuis and Wilson 1999). Based on these studies, there appears to be two separate populations: one in the Columbia Ranges and one in the Rocky Mountain Foothills. All known occurrences were within 20 km of the U.S. border (*n* = 190 creeks; Dupuis and Wilson 1999). The Columbia Ranges population is clustered within the Yahk River watershed, west of Yahk Mountain. In the Flathead, tailed frogs occur throughout the Couldrey, Cabin, Burnham, Storm, North Fork of the Bighorn and South Fork of Leslie drainages (Dupuis, pers. obs.).

Forest region and district

Southern Interior: Rocky Mountain

Ecoprovinces and ecosections

SIM: FLV, MCR, SPM

Biogeoclimatic unit

ESSF: wm
ICH: mk1, mw2
MS: dk

Broad ecosystem unit

EF (on steep south-facing slopes), AV, WR

Elevation

1190–1905 m

Life History

Diet and foraging behaviour

Adults and post-metamorphs emerge at dusk and during the night, to feed terrestrially on small arthropods within the riparian borders of streams (Metter 1964a, 1967). The diet consists primarily of spiders but other food items include Diptera (flies) and adult Trichoptera (caddisflies), Coleoptera (beetles), Lepidoptera (butterflies and moths), Hymenoptera (sawflies, ichneumons, chalcids, ants, wasps, bees), snails, ticks, mites, and crickets (Metter 1964a; Held 1985). The kinematics of prey capture in *Ascaphus* species have been described by several authors (Nishikawa and Cannatella 1991; Nishikawa and Roth 1991; Deban and Nishikawa 1992).

Tadpoles graze as they cling to gravel surfaces with their suctorial mouthparts. They consume primarily diatoms (non-filamentous algae), as well as some desmids and filamentous algae (Metter 1964a; Franz 1970b). Large amounts of pollen can be found in the intestines of larvae in the spring (Metter 1964a). It is expected that foraging opportunities for larvae are high during the summer months when productivity of algae is at its peak, and that larvae use this time to store fat for the coming winter.

Reproduction

The Rocky Mountain Tailed Frog does not reach reproductive maturity until 7 or 8 years of age (Daugherty and Sheldon 1982a) and females appear to breed every other year (Metter 1964a). In early fall, adults aggregate in the breeding creeks. Relatively high concentrations of adults have been noted in the upper reaches of breeding streams, and not in the lower reaches (T. Antifeau, pers. comm; P. Davidson, pers. comm.) during this time (August and September). Unlike most frog species, the males fertilize the eggs internally and females retain sperm until the following summer, ovipositing after spring runoff (Gaige 1920; Metter 1964b; Franz 1970a; Daugherty and Sheldon 1982a). Eggs are deposited in double strands of colourless, pea-sized ova attached to the downstream undersides of rocks (Metter 1964b; Franz 1970a; Daugherty and Sheldon 1982a; Nussbaum et al. 1983; Leonard et al. 1993), in deep pools. Tailed frogs have the largest eggs of all North American frogs (Wright and Wright 1949), and the longest embryonic period, varying from 3 to 6 weeks depending on the climate (Noble and Putnam 1931; Metter 1964a, 1967; Franz 1970a; Brown 1990).

Free-swimming larvae emerge in late August to early September (Metter 1964a; Franz 1970a). Hatchlings overwinter at the egg-laying site (Metter 1964a), feeding on the yolk sac until the following spring, when their suctorial mouth is fully developed (Brown 1990). Stream residency lasts from 1 to

5 years for *Ascaphus* species (Metter 1964a, 1967; Daugherty and Sheldon 1982a; Brown 1990; Bury and Corn 1991; Gray 1992; Bull and Carter 1996; Wahbe 1996; Wallace and Diller 1998; Bury and Adams 1999). Larval size-frequency patterns suggest a 3- to 4-year larval period for *A. montanus* (Daugherty and Sheldon 1982a). The rate of development may be related to the length of the growing season (Bury and Adams 1999), which is influenced by aspect, gradient, elevation, snowpack, and frost-free days (see Dupuis 1999). Metamorphosis occurs in late summer.

Site fidelity and home range

In Montana, breeding adults are highly sedentary, remaining in a 20 m stream segment for several years (Daugherty and Sheldon 1982b). Daugherty (1979) reported very little within- or between-stream movement of adults, and suggested that the species' recolonization potential is low. Metter (1964a) found *A. montanus* at a maximum distance of 12 m from the water's edge. Remaining near streams and maintaining small territories are likely selective advantages for securing food, mates, and shelter in the otherwise dry, inhospitable environment (Daugherty and Sheldon 1982b).

Movement and dispersal

Movements directly after metamorphosis have not been well documented. *Ascaphus* populations are remarkably discrete. They show strong genetic differences among streams (Ritland et al. 2000; Nielson et al. 2001), implying low movement potential. Daugherty and Sheldon (1982b) recorded a maximum dispersal distance of 360 m/yr for a juvenile female. Adults, especially males, disperse upstream. In the Yahk River, males were encountered 2.5:1 more than females in 1st order streams, but sex ratio was equal in 2nd and 3rd order streams (Dupuis and Friele 2002).

Habitat

Structural stage

7: old forest (>140 years)
6: mature forest (100–140 years)

Important habitats and habitat features

The presence of sedimentary or metamorphic sedimentary bedrock formations, moderate annual rainfall with a relatively high proportion of it occurring during the summer, and watersheds with low or moderate previous levels of harvest appear to be large-scale regional features in predicting the presence of tailed frogs (Wilkins and Peterson 2000). The main limitation, especially in the Flathead, is cold summer stream temperatures.

Terrestrial

Little work has been done on post-metamorphic and adult habitat associations. Tadpole-bearing creeks flow through young, mature, and old forests with structurally complex riparian zones (Franz and Lee 1970; Dupuis and Wilson 1999). A well-developed overstorey and understorey can help maintain high humidity and low temperatures (Franz and Lee 1970).

Forested riparian buffers benefit tailed frog larvae not only by moderating stream temperatures, but also by maintaining bank stability and channel characteristics (Kelsey 1995; Dupuis and Friele 1996; Dupuis and Steventon 1999). A rapid decline in the number of fine roots after trees are felled, and a sharp decrease in the tensile strength of the remaining roots, can reduce the strength of the soil mantle to the point of failure (Beschta 1978). The resulting sediment inputs to streams degrade habitat carrying capacity by increasing bedload movement and reducing interstitial refugia and foraging areas. Riparian buffers are particularly important for the Rocky Mountain Tailed Frog because the creeks in extreme southeast British Columbia have fractured and brittle bedrock, resulting in high bedload transport (see Dupuis and Wilson 1999). In addition, there appears to be strong fidelity to riparian habitats (Daugherty and Sheldon 1982b; Dupuis and Friele 2002).

Aquatic

Primary breeding habitats are step-pools of permanent mountain streams and headwaters (Dupuis 1999). Pool-riffle habitats characteristic of more gentle, fish-bearing streams, and cascade-pool habitats, where permanent boulder/log constrictions are created within a channel may also be used (see Chin 1989; Grant et al. 1990).

In the Flathead, streams between 10–16°C in the summer were most productive. In the northern interior, cold summer temperatures limit growth and development. Eggs require temperatures between 5 to 18.5°C for survival (Brown 1975). Incipient lethal water temperatures for adults range from 22°C (Metter 1966) to 24.1°C (Claussen 1973).

Larvae reach highest densities in warmer streams with stable, coarse gravel substrates (Dupuis and Friele 1996; Diller and Wallace 1999; Wilkins and Peterson 2000). Stable mountain streams are characterized by regularly spaced pools and interlocked cobble/boulder (or wood) steps that withstand moderate floods and sediment pulses (Chin 1998). An open-framework of boulders and cobbles between steps provides interstitial refugia to the tadpoles as well as stable egg-laying and overwintering sites. Conversely, sand and pebble substrates offer little shelter and foraging opportunities, and are generally avoided by tailed frog tadpoles (Franz and Lee 1970; Altig and Brodie 1972; Welsh 1993; Dupuis and Friele 1996; Welsh and Ollivier 1998).

Dupuis and Friele (2002) found that primary breeding streams were characterized by 1–10 m^3/s discharge, good summer base flow, gradients between 3 and 20%, stable, step-pool channel morphology, and summer temperatures between 10 and 16°C.

Conservation and Management

Status

The Rocky Mountain Tailed Frog is on the provincial *Red List* in British Columbia. It is designated as *Endangered* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	OR	WA	Canada	Global
S1	S3	S4	S2S3	S?	N1	G4

Trends

Population trends

Currently, the total population size of *Ascaphus* is unknown (Dupuis et al. 2000; Dupuis and Friele 2002). Most data on densities and abundances are based on in-stream (larval) surveys. Three key uncertainties prevent good estimates of *Ascaphus* population sizes: (1) fundamental demographic characteristics–especially survival rates; (2) area and carrying capacity of aquatic and adjacent riparian habitats; and (3) among-year and among-site variability (Sutherland et al. 2001). There is high, natural variability in tailed frog abundance within and among streams, governed in part by habitat characteristics and natural disturbance regimes (floods, sediment pulses, drought).

The Rocky Mountain Tailed Frog occurs in 10 tributaries in the Rocky Mountain Foothills (12 records) and 6 tributaries of the Columbia Ranges (7 records). Subpopulations are isolated from one another by the dry climatic conditions of the surrounding habitat matrix, particularly in the Columbia Ranges. The Rocky Mountain Tailed Frog may be threatened with imminent extirpation not only because of this isolation and the lengthy larval stage, low reproductive rate, and specialized habitat needs characteristic of *Ascaphus* species, but because of the low level of legal protection, threat of drought (global climate change), and the suboptimal nature of breeding habitats in the East Kootenays (Dupuis et al. 2000). Poor habitat quality is reflected in larval densities: area-constrained searches conducted in the late 1990s averaged 0.8 individuals/m^2 in the interior compared with 1.5 individuals/m^2 on the Coast (Dupuis and Wilson 1999; Dupuis et al. 2000).

Habitat trends

Suitable habitat is likely declining in British Columbia. Rocky Mountain Tailed Frog adults are largely dependent on riparian habitats adjacent to breeding sites because of the harsh thermal contrast between stream and upslope habitats in the interior. Whether non fish bearing streams are buffered depends on forestry operational constraints and professional discretion.

The Yahk watershed, where tailed frogs occur, has been altered by fire and forest harvesting (80–85% cover <100 years of age), and road densities are high (Dupuis and Friele 2002). Changes to the natural hydrological regime could have occurred and altered the habitats of tailed frogs. However, the extent of change is not known.

Threats

Population threats

Rocky Mountain Tailed Frog populations are at risk due to a restricted range (3 km radius in Columbian Ranges, 5 km radius in Border Ranges), geographic isolation, low number of occurrences (19), and low densities (0.78 ± 0.23 tadpoles/m^2). The Rocky Mountain Tailed Frog also exhibits a high level of genetic drift and possible declines in fitness (Ritland et al. 2000; Nielson et al. 2001). Reduced genetic diversity indicates that the species may have a limited capacity to migrate in response to changing conditions.

Habitat threats

Streams in the Flathead and Columbia mountains of Canada are generally underlain with brittle, meta-sedimentary rocks; as a result, they contain a large proportion of fractured bedrock as mobile bedload (Dupuis and Wilson 1999; Dupuis and Friele 2002). Unstable streams such as these are vulnerable to degradation following road building and timber harvesting activities. Road building and timber harvesting can increase the frequency and magnitude of sediment input to channel beds (Beschta 1978; Reid and Dunne 1984). The addition of woody debris to the channel can increase the risk of logjams, which trap fine sediments and alter a gully's substrate composition. Clearcut logging can also alter the hydrological regime of a watershed and accentuate peak discharges and low summer flows (Jones and Grant 1996). Several studies have reported declines in tailed frog tadpole populations following clearcut logging (Noble and Putnam 1931; Bury and Corn 1988; Corn and Bury 1989; Bury et al. 1991; Welsh and Lind 1991). In British Columbia, Dupuis and Steventon (1999) found that Coastal Tailed Frog tadpole densities were significantly lower in clearcut streams than in buffered or undisturbed streams of the north coast. Unstable streams like those within the range of the Rocky Mountain Tailed Frog in Canada are particularly vulnerable to degradation following timber-harvesting activities (Dupuis and Friele 1996).

In addition, the climate in the interior is harsh (Dupuis et al. 2000). Debris torrents, sediment floods, summer aridity, and cool summer stream temperatures probably play a significant role in local extinction and recolonization processes (Lamberti et al. 1991).

Legal Protection and Habitat Conservation

The Rocky Mountain Tailed Frog is protected, in that it cannot be killed, collected or held in captivity without special permits, under the provincial *Wildlife Act.* If salmonid habitat exists downstream, some level of protection may be provided through the *Fisheries Act*.

No populations occur within a protected area.

The results based code may provide protection through the establishment of old growth management areas (OGMAs) provided these overlap with known sites or suitable habitat. In addition, riparian management guidelines provide a measure of protection for riparian habitats, particularly for streams with game fish. However, since most populations of the Rocky Mountain Tailed Frog are found in small streams without fish, they are not protected by FRPA riparian management recommendations. These recommendations do not recommend retention of a riparian reserve zone on small streams where "game" fish are not present. However, they do recommend that forest practices in management zones adjacent to streams classified as S4–S6 (small fish or non fish bearing) be planned and implemented to meet riparian objectives. These objectives can include retaining sufficient vegetation to provide shade, reduce microclimatic changes, maintain bank stability and, where specified, may include objectives for wildlife, fish habitat, channel stability, and downstream water quality.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

In landscapes or those portions of landscapes (i.e., catchment areas for streams with tailed frogs) documented to contain tailed frog populations consider the following recommendations:

- ❖ Wherever appropriate use OGMAs to protect known tailed frog occurrences and suitable riparian habitats.
- ❖ Maximize connectivity of riparian habitats, particularly between WHAs and adjacent stream reaches.
- ❖ Increase retention on streams classified as S5 or S6 to maintain thermal conditions.
- ❖ Minimize use of chemical applications (e.g., dust-palliative polymer stabilizers and soil binders that can be sprayed within ditch lines).
- ❖ Minimize site disturbance during harvesting, especially in areas with high sediment transfer potential to natal streams.
- ❖ Fall and yard away from, or bridge, stream channels (ephemeral or perennial) to reduce channel disturbance and slash loading.
- ❖ Consider both the risk of desiccation and risk of sedimentation when determining size of cutblocks. Larger blocks can be accessed and yarded with a less dense road system, thus decreasing the potential sedimentation impacts but may have a greater impact on summer flows by having a more significant effect on the clearcut equivalent ratio and by increasing the wind fetch on streamside buffers. However, where desiccation is of greater concern, smaller block sizes may be more appropriate. Sedimentation risk may be offset by incorporating careful road planning and maintenance as described below.
- ❖ Construct narrow roads to minimize site disturbance and reduce groundwater interception in the cutslope and deactivate roads but minimize digging and disturbance to adjacent roadside habitat.
- ❖ Maintain naturally dispersed water flows (seepages, non-classified drainages and streams should be supplied with cross-drainage structures where crossed by roads).
- ❖ Use sediment-control measures in cut-and-fill slopes (e.g., grass-seeding, armouring ditch lines, and culvert outfalls).
- ❖ Develop a plan to consider issues of hydrological green-up and runoff response.

Wildlife habitat area

Goal

Maintain and link tailed frog streams and breeding areas.

Feature

Establish WHAs at streams that are characterized by (1) presence of tadpoles or adults; (2) year-round stream flow (i.e., perennial streams); (3) low to moderate gradients (<50%); (4) coarse gravel substrates (cobbles and boulders); (5) stable channel beds; and (6) forest cover. WHAs should be established in the headwaters of Cabin Creek, Couldrey Creek, and Yahk River (west of Yahk Mountain).

Size

Typically 100 ha (range 50–150 ha) but will ultimately depend on site-specific factors including the number and length of streams included and terrain stability.

Design

Ideally, the WHA should include several interconnected stream reaches (S4–S6) with evidence of presence of tailed frogs. The boundaries of a WHA should be designed to maintain stream conditions (substrate, temperature, macro-invertebrate, and algae communities) and connectivity between streams. The WHA should include a core area that extends 30 m from the water's edge on both sides and a 20 m management zone surrounding the core area.

General wildlife measures

Goals

1. Maintain clean and stable cobble/boulder gravel substrates, natural step-pool channel morphology, and stream temperatures within tolerance limits.
2. Maintain microclimatic, hydrological, and sedimentation regimes to (1) limit the frequency of occurrence of extreme discharge events, (2) limit the mortality rate of tailed frogs during floods, and (3) meet foraging and dispersal requirements of the adults and metamorphs.
3. Maintain riparian forest.
4. Maintain important structural elements (e.g., coarse woody debris).
5. Maintain water quality and naturally dispersed water flows.

Measures

Access

- Minimize roads or stream crossings within the core area. When stream crossings are determined to be necessary, use cross-drainage structures particularly bridges or open-bottomed culverts and ensure type of crossing structure and any associated roads are designed and installed in a manner that minimizes impacts to tailed frog instream and riparian habitats. When roads are determined to be necessary, minimize length and construct narrow roads to minimize site disturbance and reduce groundwater interception in the cutslope; use sediment-control measures in cut-and-fill slopes (e.g., grass-seeding, armouring ditch lines, and culvert outfalls); deactivate roads but minimize digging and disturbance to adjacent roadside habitat; minimize site disturbance during harvesting, especially in terrain polygons with high sediment transfer potential to natal streams; and fall and yard away from, or bridging, all other stream channels (ephemeral or perennial) within the WHA, to reduce channel disturbance and slash loading.

Harvesting and silviculture

- Do not harvest within the core area.
- No salvage should be carried out.
- In the management zone, use partial harvesting systems that maintain at least 70% basal area with the appropriate structure necessary to achieve the goals of the GWM.
- Wherever possible and practicable, augment management zone using wildlife tree retention areas.
- Do not use chemical applications (e.g., dust-palliative polymer stabilizers and soil binders that can be sprayed within ditch lines).

Pesticides

- Do not use pesticides.

Range

- Control livestock use. Fencing may be required by the statutory decision maker to achieve goals.

Additional Management Considerations

Manage stream reaches adjacent to WHA according to the recommended riparian management "best management practices." Where livestock grazing occurs follow the "target conditions for range use in stream riparian areas" from riparian management recommendations.

In extensively developed areas, management of the WHA should focus on channel restoration including channel and gully assessments, in-stream work to restore step-pool morphology and reduce sediment transport, stream-side planting to stabilize banks, and road deactivation to reduce sediment inputs.

Prevent fish introductions and rechannelization of areas supporting tailed frog populations.

Maintain slash-free headwater creeks and forested riparian buffers, especially within fragmented areas.

On S5 and S6 streams containing tailed frogs, retain structure especially on south side of east–west or west–east flowing streams to shade streams.

Information Needs

1. Detailed description of larval distribution and abundance within documented streams of occurrence; resurvey Gilnockie Creek drainage.

2. Channel assessment and habitat suitability ranking for tadpole-bearing creeks.
3. Age-specific movement/dispersal patterns and requirements of adults and post-metamorphs.

Cross References

Grizzly Bear, Williamson's Sapsucker (*nataliae* subspecies), Wolverine

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Reptiles

"Great Basin" Gopher Snake

Pituophis catenifer deserticola

Original[1] prepared by Nadine Bertram

Species Information

Taxonomy

The Gopher Snake *(Pituophis catenifer*) is a member of the family Colubridae that includes the majority of the world's non-venomous snake species. Six subspecies of *P. catenifer* are currently recognized, two of which have been documented in British Columbia: *P. catenifer catenifer* and *P. catenifer deserticola* (Gregory and Gregory 1999). *P. catenifer deserticola*, hereafter referred to as the Great Basin Gopher Snake, is confined to the Southern Interior of British Columbia, while *P. catenifer catenifer* is suspected to be extirpated from British Columbia (Cannings et al. 1999).

Description

Adults are generally between 70 and 200 cm, but may exceed 240 cm (Gregory and Campbell 1984; Shewchuk 1996). They are usually very light brown or yellowish-brown with superimposed dark brown-black squares running from the head to the tail; on the tail the squares become more like stripes or cross-bands (Gregory and Campbell 1984). Smaller, more irregularly shaped dark brown-black markings occur along the sides of the body and the ventral surface is a creamy yellowish colour (Gregory and Campbell 1984). Scutes on the snakes back are lightly keeled, while all other body scutes are smooth; two rows of subcaudal scutes are present (Gregory and Campbell 1984).

The head is slightly wider than the neck; the eyes are relatively large with a round pupil (Gregory and Campbell 1984). Three distinctive markings (dark brown-black) occur on the head, including a horizontal band between the eyes, a vertical line running from below the eye to the upper jaw, and an angled stripe running from the eye to the angle of the jaw (Gregory and Campbell 1984).

Distribution

Global

The Great Basin Gopher Snake occurs in southern British Columbia and the western United States including Washington, Oregon, Colorado, Nevada, Wyoming, Arizona, and New Mexico.

British Columbia

The Great Basin Gopher Snake has a patchy distribution throughout the warm, dry grassland valleys of the interior with the highest population densities occurring in low elevation areas of the Thompson and Okanagan valleys. Gopher snakes also occur in the Fraser Valley (from at least as far south as Lytton north to Churn Creek) and the Nicola and Similkameen valleys (Hobbs and Sarrel 2000), and have also been found in the Kettle Valley, from Rock Creek east to Christina Lake (Hobbs and Sarell 2000).

Forest region and districts

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Kamloops, Okanagan Shuswap (Salmon Arm)

Ecoprovinces and ecosections

CEI: FRB

SOI: NOB, NOH, OKR, PAR, SHB, SOB, SOH, STU, THB, TRU

Biogeoclimatic units

BG: xh, xw

IDF: xh (including a and b phases), xm, xw

PP: dh1, dh2, xh1

1 Volume 1 account prepared by C. Shewchuk.

Gopher Snake - subspecies *deserticola*
(Pituophis catenifer deserticola)

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Broad ecosystem units

AB, BS, CR, DP, OV, PP, SS, UR

Elevation

250–1100 m

Life History

Diet and foraging behaviour

The Great Basin Gopher Snake uses constriction to kill its prey before ingesting it. Shewchuk (1996) found that in the south Okanagan, small rodents, such as voles, pocket mice, and deer mice, comprised 91% of the gopher snakes diet and juvenile birds accounted for the remaining 9%. Shewchuk (1996) found a high abundance of neonate rodents and juvenile swallows (*Hirundo* spp.) in the diet, indicating that gopher snakes actively forage by searching rodent burrows and by climbing to reach bird nests. Seigel and Collins (1993) found that as air and ground temperatures increase from 18 to 27°C, the activity, movements, and prey capture success of the gopher snake also increased.

Reproduction

Mating occurs in May. Typically ovulation follows in early June and the eggs are deposited between late June and early July (Parker and Brown 1980; Shewchuk 1996). In the south Okanagan, Shewchuk (1996) reported that gravid females (n = 19) deposited between two and eight eggs each (mean, 4.6) and clutch size was significantly correlated to female snout-vent-length. Egg-laying sites are known to occur in abandoned rodent burrows in sandy substrates, commonly in flat areas or on south-facing slopes; talus slopes in rocky habitats also may be used (Parker and Brown 1980; Shewchuk 1996). Nest sites often are communal, containing the eggs of several females, and often include the eggs of other species such as the Racer *(Coluber constrictor mormon)* (Parker and Brown 1980; Shewchuk 1996). Incubation occurred for ~60–80 days and hatchlings emerged in late August or early September (Shewchuk 1996).

Site fidelity

Successive use and fidelity to hibernacula, egg-laying sites, and foraging areas has been documented in Utah and the south Okanagan (Parker and Brown 1980; Shewchuk 1996). In addition, Shewchuk (1996) observed the repeated use of "retreat sites" (locations that provide shelter and thermal protection) in the south Okanagan. Retreat sites were used repeatedly by individuals to provide cover when the snakes were not actively foraging. Several gopher snakes were observed returning to these areas within and across active seasons.

Home range

Gopher snakes studied in the south Okanagan were found to have relatively large mean home ranges (13.9 ha females, 5.3 ha males) compared with those studied in Utah (1–3 ha), possibly due to a different distribution of food resources and critical habitats (Shewchuk 1996). In the Thompson, the approximate summer home range sizes of two male gopher snakes were 5 ha and 18 ha, respectively, and one gravid female used a home range of ~25 ha (Bertram and Larsen 2001). One possible explanation for the large size of female home ranges in the south Okanagan (and Thompson) may be large movements to suitable egg-laying sites that may be located some distance from the snakes primary foraging habitat (Shewchuk 1996).

Movements and dispersal

In British Columbia, this species hibernates in dens for a large part of the year (November to March). The over wintering sites are often communal, and typically shelter more than one snake species (i.e., *Crotalus oreganus, Coluber constrictor, Hypsiglena torquata, Thamnophis elegans*). Depending on weather, the snakes emerge from hibernation in late March or early April. Shortly after emergence from hibernation the snakes disperse to summer foraging and egg-laying habitats. In the south Okanangan, Shewchuk (1996) found a mean dispersal/return distance of 934 m. A study in the Kamloops area found return distances of between 275 and 520 m (Bertram and Larsen 2001).

The majority of movements during the summer feeding period are usually <200 m; between feedings or during ecdysis (shedding), the Great Basin Gopher Snake may be inactive for 10–15 days (Parker and Brown 1980; Shewchuk 1996; Bertram and Larsen 2001). Gravid females may travel substantial distances to locate suitable egg-laying sites. Migrations of 440 m and 2188 m have been observed (Shewchuk 1996; Bertram and Larsen 2001). Movements during the spring and fall usually are diurnal while during the summer the snakes may become nocturnal to avoid the heat (Greene 1997).

Habitat

Structural stage

1: non-vegetated/sparse
2: herb
3: shrub/herb

Important habitats and habitat features

Denning

Most known den sites are located within rock outcrops or talus habitat. These sites provide specific thermal and moisture regimes that protect snakes from freezing and dehydration. Most den sites are located on south-facing slopes in the Ponderosa Pine or Bunchgrass biogeoclimatic zones (Hobbs and Sarell 2000; Bertram and Larsen 2001). Hibernacula have been found in various areas, for example within a talus slope below a cliff, and in horizontal rock cracks at the base of cliffs (Shewchuk 1996). In general, dens have been located at elevations of ~450 m (Shewchuk 1996; Bertram and Larsen 2001). In some cases gopher snakes may hibernate alone or with a relatively small number of snakes in rodent burrows or other inconspicuous openings. Two gopher snakes in the Thompson area were observed overwintering in areas such as these. One is a rodent hole complex on the southeast facing slope of a small gully in open grassland habitat (elevation 400 m); the second is an opening produced by a dead and decaying sagebrush in the coarse gravel of a railway bed (elevation 350 m) (Bertram and Larsen 2001).

Breeding

Egg-laying sites also tend to be on south-facing slopes, but are more likely to be found in abandoned rodent burrows than in talus or rock outcrops. Several egg-laying sites in the south Okanagan and one in the Thompson have been found near the crest of large sand banks (Shewchuk 1996; Bertram and Larsen 2001). These sites contained minimal vegetation with loose, sandy soils, probably enabling partial excavation by the snakes. The sites also appeared to be well drained and were south to southeast facing. Studies indicate that egg-laying sites may be selected based on specific thermoregulatory criteria to ensure optimum conditions for development of the embryos (Shewchuk 1996).

Foraging

Gopher snakes tend to forage in open grassland habitats but riparian areas within the grassland habitat may also be important. Shewchuk (1996) found that after dispersal, individual gopher snakes spent most of their time moving in the riparian habitats of the south Okanagan study area; two of three gopher snakes followed in the Thompson had a riparian component within their home range (Bertram and Larsen 2001). The third gopher snake foraged in an open grassland habitat that included two dry gullies but no riparian areas, several other gopher snakes were observed in this area throughout the summer (Bertram and Larsen 2001). In the Kamloops area, rodent holes and to a lesser extent, rock outcroppings and wildlife trees (class 8 and 9 [dead fallen]) were observed to be important sources of cover for the snakes (Bertram and Larsen 2001). These sites offer physical cover and thermal protection for the snakes between foraging movements (Shewchuk 1996).

Conservation and Management

Status

The Great Basin Gopher Snake is on the provincial *Blue List* in British Columbia. Its status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	BC	ID	MT	OR	WA	Canada	Global
S3*[a]	S3	S5*	S5*	S5*	S5*	N3	G5T5

a NatureServe has not yet assessed the status of this subspecies; thus, these ranks reflect the status at the species level and are not specific to the *deserticola* subspecies.

Trends

Population trends

Estimates of abundance in British Columbia are not available. This snake is known to occur at many locations within the Thompson, Okanagan, Similkameen, and Fraser valleys, but critical habitats such as communal hibernacula have not been identified in most cases; therefore population monitoring is very difficult. Although population data are not available, significant development has occurred and continues to occur in areas known to support gopher snakes (see below); population declines due to habitat loss in the past, present, and future are therefore highly probable.

Habitat trends

Since settlement of the southern interior began, significant alteration of snake habitat has occurred. Most human developments, such as residential, industrial, and agricultural, occur within the valley bottoms. As human populations increase, development also is accelerating; this trend is evident throughout the range of the Great Basin Gopher Snake, particularly in the south Okanagan and Similkameen (SOS 2000).

Threats

Population threats

The Great Basin Gopher Snake has a restricted range in the province. Its populations are also seasonally concentrated at den sites, causing this species to be susceptible to disturbance and local extirpation. Specific microclimatic conditions make these sites unique and they are limited within the habitat (Shewchuk 1996). Entire snake populations may be destroyed if these sites are lost or altered as a result of human activities or natural occurrences.

Roads and railways that bisect the summer range of this snake represent a significant source of mortality, as gopher snakes often are killed or injured while migrating across or basking in these locations (Shewchuk 1996; Bertram and Larsen 2001). Mortality caused by agricultural activities such as cattle grazing and crop harvesting also is evident in the south Okanagan and Thompson areas (Shewchuk 1996; Bertram and Larsen 2001). In addition, the superficial resemblance of this non-venomous snake to the venomous Western Rattlesnake *(Crotalus oreganus)* results in unfounded persecution (Bertram and Larsen 2001).

Habitat threats

In British Columbia, the main threat to this species is habitat loss and alteration due to urban and agricultural development and livestock grazing. Grazing is likely to increase exposure to predators by causing a reduction of available ground cover within critical summer habitats (Hobbs and Sarell 2000; G. Schuett, pers. comm.). Human developments in the grassland/shrub-steppe habitat are expanding, resulting in population declines and loss of species, particularly vertebrates (SOS 2000).

Road development also contributes to habitat fragmentation and loss (Shewchuk 1996; Bertram and Larsen 2001). Recreational activities such as all-terrain vehicle use currently pose a minor threat to habitat through compaction and degradation of soils and vegetation.

Legal Protection and Habitat Conservation

The Great Basin Gopher Snake is protected in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act*.

Several ecological reserves (i.e., Tranquille, Haynes Basin) and provincial parks (i.e., Lac du Bois, Kalamalka Lake) contain suitable gopher snake habitat. At least seven known hibernacula are within protected areas including Okanagan Mountain and Kalamalka provincial parks; Trout Creek and Thorne ecological reserves; and White Lake, Churn Creek, and South Okanagan Grasslands protected areas.

Under the results based code, range use plans that consider the requirements of this species may be sufficient to meet the needs of the species. However, for a species to be specifically addressed within these plans, they must be designated as Identified Wildlife. Wildlife habitat features may be used to protect den sites.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

❖ Maintain and maximize connectivity between hibernacula and foraging habitats.

Wildlife habitat area

Goal

Maintain and link denning and foraging habitat, travel corridors, and egg-laying sites within and between adjacent populations.

Feature

Establish WHAs at communal dens, especially for multi-species dens, and talus slopes, rock outcrops or cliff habitats identified to be important for the conservation of this species.

Size

Approximately 200–300 ha but will depend on site-specific factors such as area of suitable habitat, nearness to foraging areas, and egg-laying sites.

Design

The boundaries of the WHA should be designed to include and connect den sites, travel corridors, egg-laying sites, and important foraging areas.

General wildlife measures

Goals

1. Minimize disturbance and mortality, particularly road mortality.
2. Maintain critical structural elements such as rock outcrops, talus slopes, friable soils, coarse woody debris, friable soils, rodent burrows, concentrations of boulders, or other unconsolidated materials and vegetative cover.
3. Maintain microclimatic conditions of hibernacula.
4. Maintain moderate to dense cover to conceal snakes and maintain foraging opportunities.
5. Maintain WHA in a properly functioning condition.

Measures

Access

- Place roads as far as practicable from hibernacula and known snake travel corridors. Avoid construction between April and October when snakes are active. When recommended by MWLAP, rehabilitate temporary access roads immediately after use or gate less temporary roads to reduce traffic.
- Where determined to be necessary by MWLAP, use snake drift fences and drainage culverts at intersections of roads and known travel corridors. Drift fences should be ≥75 cm high. Length will vary by site depending on area used by snakes. Consult MWLAP for more information. Seasonal use restrictions may be appropriate for some roads. Do not remove or disturb rock or talus.

Harvesting and silviculture

- Do not harvest within 200 m of den sites. Retain coarse woody debris.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing (e.g., timing, distribution, and level of use) to prevent trampling and maintain suitable vegetative cover (i.e., >15 cm height in upland areas; >10 cm height in riparian areas).
- Do not concentrate livestock within 200 m of den site during spring dispersal (March/April) and fall (September/October) aggregations.
- Do not place livestock attractants or corrals within 200 m of den site.
- Do not trail livestock within 200 m of den site during spring and fall aggregations.
- When hay cutting or prescribed burning is planned, consult with MWLAP for the preferable times (i.e., after snakes have returned to dens).

Recreation

- Do not establish recreation sites within WHA.

Additional Management Considerations

Where migration routes from denning locations to summer habitats have been transected by roads, use methods such as drift fences, culverts, or seasonal road restrictions to allow the safe passage of snakes.

Rock climbing should be considered a disturbance at sensitive sites.

Riparian areas adjacent to WHA should be managed or restored to ensure foraging habitat is maintained.

Avoid converting areas adjacent to WHA to an early seral grassland condition. Early seral stages may have less cover for concealing snakes from predators and they may experience greater threats from trampling due to higher livestock pressures.

Information Needs

1. Inventory of hibernacula, egg-laying sites, and foraging areas.
2. Monitoring of hibernacula to provide population data.
3. Increased knowledge of life history, specifically reproduction.

Cross References

Badger, Racer, Western Rattlesnake

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RACER

Coluber constictor mormon

Original[1] prepared by Mike Sarell

Species Information

Taxonomy

Racers belong to the largest family of snakes, the Colubridae. The genus *Coluber* is represented by one species in British Columbia (Gregory and Gregory 1999). Eleven subspecies are described (Wilson 1978) but only *C. constictor mormon* occurs in British Columbia (Gregory and Gregory 1999). This subspecies may represent a distinct species (Fitch et al. 1981) but this is not widely accepted (Corn and Bury 1986).

Description

Racers have long, sleek bodies. Adults are a uniform olive to bluish grey dorsally, with a yellowish venter that often becomes whiter toward the throat and head (Brown et al. 1995). Young resemble Gopher Snakes (*Pituophis catenifer deserticola*), as there is a series of saddle-shaped markings along the back (Matsuda et al., in press). This pattern gradually fades from the tail toward the head during the first year. Racers seldom reach lengths >1 m (Matsuda et al., in press).

Distribution

Global

Racers are found throughout much of the United States, bordering parts of Canada and down into Central America. *Coluber constrictor mormon* occurs in the Pacific Northwest south to California (Brown et al. 1995).

British Columbia

In British Columbia, Racers generally occur in the south and central interior. Populations are known from the south Columbia, Kettle, Okanagan, Similkameen, Nicola, Thompson, and Fraser watersheds but there are two records from Anderson Lake (J. Hobbs pers. comm.) and Churn Creek.

Forest region and districts

Coast: Squamish

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Kamloops, Okanagan Shuswap

Ecoprovinces and ecosections

CEI: FRB

SIM: SFH

SOI: GUU, LPR, NIB, NOB, NOH, OKR, PAR, SCR, SHB, SOB, SOH, STU, THB, TRU

Biogeoclimatic units

BG: xh, xw

ICH: dw, mk1, xw

IDF: dm, mw, ww, xh, xm, xw

PP: dh, xh

Broad ecosystem units

AB, BS, CF, CR, DF, DP, IH, LS, OV, PP, RO, SS

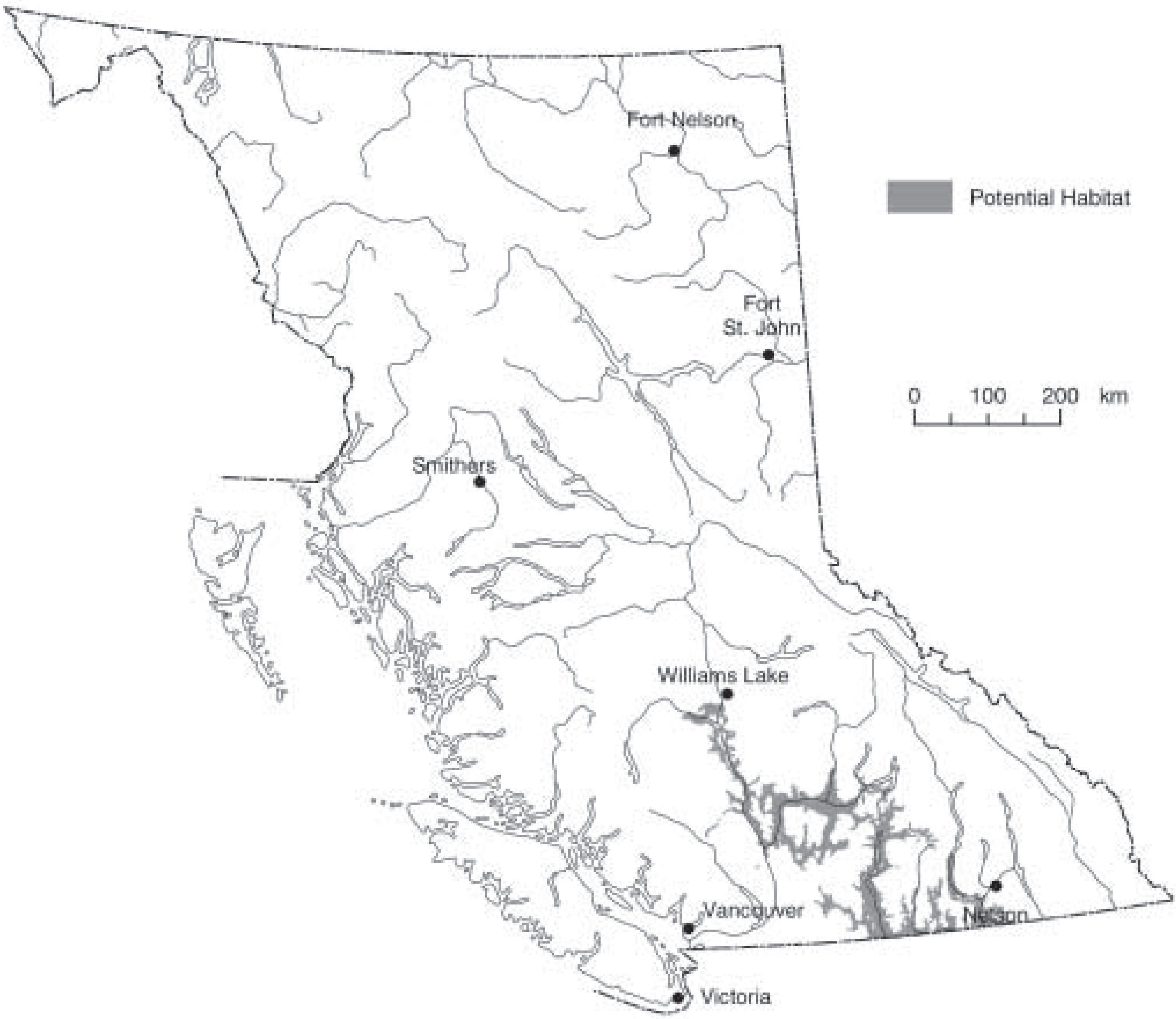
Elevation

Generally found at low to mid-elevations, up to almost 900 m in British Columbia (Sarell et al. 1997) and up to 1080 m in Washington State (Brown et al. 1995).

1 Volume 1 account prepared by C. Shewchuk.

Racer

(Coluber constrictor)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Life History

Diet and foraging behaviour

Racers are generalists, preying on small mammals, lizards, snakes, and insects (Brown et al. 1995). Racers are atypical of other British Columbia snake species, as they seem to demonstrate a greater dependency on vision when foraging and navigating. Prey are stealthily approached, ambushed, or chased. Unlike the scientific name implies, Racers do not constrict their prey but instead swallow their prey alive. Young Racers are suspected to feed predominantly on crickets and grasshoppers (Brown et al. 1995).

Reproduction

Racers mate shortly after emergence from winter dens. Between three to seven eggs are laid (June–July) in subterranean chambers on warm slopes. Racers will sometimes take advantage of other snake egg-laying sites and have been documented sharing egg-laying sites with Gopher Snakes (Shewchuk 1996). Eggs hatch almost 2 months after laying (August), although the development period is suspected to partially depend on incubation temperature (Shewchuk 1996).

Site fidelity

Racers are suspected to use the same den throughout their lives. Repeated use of summer home ranges is also suspected (Brown et al. 1995). The same egg-laying site may be used for several years.

Home range

Although these snakes are probably the most active of the snakes in British Columbia and are able to travel great distances over short periods, they tend to have discrete summer home ranges (Brown et al. 1995). Home ranges are usually located within 1 km of the den but one record shows a movement of almost 2 km (Brown et al. 1995). Daily movements of approximately 200 m have been documented within their home ranges during the summer foraging period (Shewchuk and Waye 1995).

Movements and dispersal

Snakes emerge in late March and April and travel from the den before mating in May. Racers have been reported to travel up to 1.8 km from the den to reach summer range (Brown et al. 1995). During the summer, daily movements are typically small (<100 m); however, gravid females may make larger journeys (>500 m) to reach egg-laying sites in July.

Habitat

Structural stage

Racers are most common in non-forested ecosystems. Where they do occur in forested habitats, they seem to prefer openings (Sarell et al. 1997; Sarell and Alcock 2000). Structural stage does not appear to be important, providing the canopy is not closed. It is not known whether Racers are impacted by grassland seral condition but it is possible that a reduction in cover may lead to greater predation. They can be found in all range conditions, however, they are more conspicuous in grazed grasslands.

Important habitats and habitat features

Denning

Racers hibernate during the winter (November through March). Dens may be used by solitary individuals but most often Racers share their den with other individuals and often den communally with other species of snakes (Brown and Parker 1976; Macartney 1985; Charland 1989; Radke 1989; Sarell 1993) such as Gopher Snakes and Western Rattlesnakes (*Crotalus oreganus*).

Dens are usually found on warm slopes in rock outcroppings or talus (Sarell 1993) in grasslands or open forest habitats. Den sites are suspected to be used in consecutive years, which may reflect a scarcity of special conditions required for suitable refuge from winter conditions. Den sites have also been found on warm slopes of unconsolidated material, usually glacio-fluvial deposits (Sarell and Alcock 2000). These dens house fewer individuals and are probably transitory due to gradual sloughing. Evidence from Washington State suggests that Racers are also able to den in small mammal burrows under the base of shrubs (Folliard and Larsen 1990).

Breeding

Eggs are laid in subterranean chambers on warm slopes. These chambers are sometimes excavated in soft, sandy banks although females will more typically use abandoned rodent burrows when available.

In the south Okanagan, egg-laying sites have been found near the crest of a sandy hill, with little surrounding vegetation (Shewchuk and Waye 1995; Shewchuk 1996).

Foraging

Foraging habitats are most often shrub-steppe and grasslands (Matsuda et al., in press), although open forests and riparian areas are also used.

Conservation and Management

Status

The Racer is on the provincial *Blue List* in British Columbia. It is designated as *Not at Risk* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	CA	OR	ID	MT	WA	Canada	Global
S3S4	S5	S4?	S5	S5	S5	N4	G5

Trends

Population trends

Racers often appear to be the most abundant snake in arid ecosystems. Estimating their apparent relative abundance is misleading, as they are active during the day and are obvious when active, which increases the probability of detection. Populations seem to be most abundant in the south Okanagan and Lower Similkameen. Population studies have not been conducted but Racers are one of the most commonly killed snake species on roadways (M. Sarell, pers. obs.). It is suspected that population declines are widespread and significant (Campbell and Perrin 1990).

Habitat trends

The arid landscapes occupied by Racers probably remained suitable during the mining and ranching eras but intensive agricultural developments and rapid urbanization in recent years has significantly altered their habitats. In the late 1980s, it was calculated that about 10% of ecosystems in the south Okanagan remained relatively undisturbed (Redpath 1990).

Threats

Population threats

Populations are seasonally concentrated at den sites, causing this species to be susceptible to disturbance and local extirpation. Hibernating populations are vulnerable to mortality from earth-moving activities. During the summer, individuals are often killed by domestic cats and humans when they are encountered in agricultural areas. Road construction, urban developments, utility construction, and quarrying are the most likely activities to impact communal dens. Individual Racers are prone to mortality from vehicle traffic, intensive agricultural practices, and domestic pets.

Habitat threats

In British Columbia, the main threat to this species is habitat loss due to human development. This includes urbanization, agriculture, and the development of utility corridors. Road mortality is also of concern. Human population growth, roads, and volume of traffic have increased over the last few years in the south Okanagan and are expected to continue to increase. Road use statistics are available for a number of highways in the south Okanagan (B.C. Ministry of Highways 1999). In the summer, use of paved roads ranged from 2872 vehicles per summer day just north of the Canadian border at Osoyoos to 20 017 vehicles per summer day on the highway near Penticton.

Livestock grazing may be a concern in heavily or intensively grazed grasslands. Impacts from grazing may include trampling, reduced movements during critical foraging and mating periods, changes to habitat structure that may result in increased predation, and reduced prey abundance (Macartney and Weichel 1989; Didiuk and Macartney 1999). However, the impacts of livestock grazing have not been well studied and results are contradictory.

Legal Protection and Habitat Conservation

Under the provincial *Wildlife Act*, the Racer is protected in that it cannot be killed, collected or held in captivity without special permits.

A number of communal dens occur within protected areas including Okanagan Mountain Provincial Park, Kalamalka Provincial Park, Throne Ecological Reserve, White Lake Protected Area, Kobau Provincial Park, Churn Creek Protected Area, as well as other areas managed for conservation (e.g., Nature Trust of BC). However, many communal dens are isolated from protected areas and continuums of habitat are not protected.

Under the results based code, range use plans that consider the requirements of this species may be sufficient to meet the needs of the species. However, for a species to be specifically addressed within these plans, they must be designated as Identified Wildlife. Wildlife habitat features may be used to protect den sites.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

❖ Maintain and maximize connectivity between hibernacula and foraging habitats.

Wildlife habitat area

Goal

Maintain and link denning habitat, foraging habitat, travel corridors, and egg-laying sites within and between adjacent populations.

Feature

Establish WHAs for communal dens, especially multi-species dens, and talus slopes, rock outcrops, or cliff habitats identified to be important for the conservation of this species.

Size

Approximately 200–300 ha but will depend on site-specific factors such as area of suitable habitat, nearness to foraging areas, and egg-laying sites.

Design

The boundaries of the WHA should be designed to include and connect den sites, travel corridors, egg-laying sites, and important foraging areas.

General wildlife measures

Goals

1. Minimize disturbance and mortality, particularly road mortality.
2. Maintain critical structural elements such as rock outcrops, talus slopes, friable soils, coarse woody debris, concentrations of boulders, or other unconsolidated materials and vegetative cover.
3. Maintain microclimatic conditions of hibernacula.
4. Maintain moderate to dense cover to conceal snakes and maintain foraging opportunities.
5. Maintain riparian areas in a properly functioning condition.

Measures

Access

- Place roads as far as practicable from hibernacula and known snake travel corridors. Avoid construction between April and October when snakes are active. When recommended by MWLAP, rehabilitate temporary access roads immediately after use or gate less temporary roads to reduce traffic.
- Where determined to be necessary by MWLAP, use snake drift fences and drainage culverts at intersections of roads and known travel corridors. Drift fences should be ≥75 cm high. Length will vary by site depending on area used by snakes. Consult MWLAP for more

information. Seasonal use restrictions may be appropriate for some roads.
- Do not remove or disturb rock or talus.

Range

- Plan livestock grazing (e.g., timing, distribution, and level of use) to prevent trampling and maintain suitable vegetative cover (i.e., >15 cm stubble height in upland; >10 cm in riparian areas).
- Do not concentrate livestock within 200 m of den during spring dispersal (March/April) and fall (September/October) aggregations.
- Do not place livestock attractants or corrals within 200 m of den site.
- Do not trail livestock within 200 m of den site during spring and fall aggregations.

Pesticides

- Do not use pesticides.

Recreation

- Do not establish recreation sites within WHA.

Additional Management Considerations

Where migration routes from denning locations to summer habitats have been transected by roadways, use methods such as drift fences, culverts, or seasonal road restrictions, to allow the safe passage of snakes.

Rock climbing should be considered a disturbance at sensitive sites.

Riparian areas adjacent to WHAs should be managed or restored to ensure range foraging habitat is maintained.

Avoid converting areas adjacent to WHAs to an early seral grassland condition. Early seral stages may have less cover for concealing Racers from predators and may experience greater threats from trampling due to higher livestock pressures.

Information Needs

1. Identification of hibernacula sites and characteristics.
2. Dispersal behaviour from dens.
3. Foraging habitats.

Cross References

Bighorn Sheep, "Great Basin" Gopher Snake, Lewis's Woodpecker, White-headed Woodpecker, water birch – red-osier dogwood

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WESTERN RATTLESNAKE

Crotalus oreganus

Original[1] prepared by Mike Sarell

Species Information

Taxonomy

The taxonomy of this species is currently under review (Douglas et al. 2003) and taxonomic changes will be made in the winter of 2002–2003. Genetic analysis, coupled with geographic isolation, has prompted the investigators to recognize the Western Rattlesnake, *Crotalus oreganus,* as its own distinct species. The Western Rattlesnake is the only rattlesnake species found in British Columbia (Gregory and Gregory 1999).

Description

The Western Rattlesnake exhibits a high degree of colour and pattern variation within its range in British Columbia. Juvenile rattlesnakes have distinct dark brown dorsal markings edged with pale margins on a base colour of light grey or beige. As rattlesnakes mature the dorsal markings become less distinct and the base colour darkens to a dull shade of green. Black and white bands, typically beginning posterior to the vent, encircle the tail anterior to the conspicuous rattle. A brown horizontal stripe, bordered in white, runs from outside corner of the eye to the corner of the mouth. In both juveniles and adults the dorsal scales are heavily keeled giving the snakes a dull or dirty appearance. This moderate-sized snake grows to a maximum length of 1.2 m but large individuals of this size are rarely encountered.

Distribution

Global

The Western Rattlesnake occurs in northwestern North America. It extends from western and northern Oregon, into west-central Idaho, Washington east of the Cascade Mountains, and as far north as south-central British Columbia (Nussbaum et al. 1983).

British Columbia

The Western Rattlesnake is restricted to the very dry B.C. interior. It is known from the Similkameen, Okanagan, Kettle, Lower Nicola, South Thompson, and Fraser valleys (Hobbs and Sarell 2001). Klauber (1972) acknowledged that they may extend into the extreme south Columbia near Trail and there is one record for Castlegar (Royal B.C. Museum record). Rattlesnakes appear to be locally distributed within the hot and dry subzones of the Bunchgrass, Ponderosa Pine, and Interior Douglas-fir (IDF) biogeoclimatic zones within their known range. They may also occur in restricted portions of the Montane Spruce and Engelmann Spruce—Subalpine Fir biogeoclimatic zones (e.g., Mt. Kobau). The Thompson/Fraser population appears to be geographically disjunct from all other populations. This separation was probably formed sometime since the hypsithermal period of about 8000 years ago. The original path of expansion into the province, following the last ice age, was probably up through southern main valleys of the province (e.g., Similkameen, Okanagan, Kettle, Columbia) with the Okanagan continuing into the Thompson, through the Falkland area. From there, expansion continued along the Fraser River Valley. The Thompson population also may have bridged into the Similkameen via the Summers, Allison, and Otter drainages, through the IDFdk biogeoclimatic subzone. Climate and availability of denning habitats appear to be the primary constraint to their distribution in British Columbia. Habitats with suitable foraging habitat and prey base, as well as conspecifics (e.g., Racer, *Coluber constrictor*, and

1 Volume 1 draft prepared by M. McCartney.

Western Rattlesnake
(Crotalus oreganus)

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

"Great Basin" Gopher Snake, *Pituophis catenifer deserticola*), extend beyond their current distribution.

Forest region and districts

Southern Interior: Arrow Boundary, Cascades, Kamloops, Okanagan Shuswap

Ecoprovinces and ecosections

SIM: SFH

SOI: GUU, NIB, NOB, NOH, NTU (?), OKR, PAR, SOB, SOH, STU(?), THB, TRU

Biogeoclimatic units

BG: xh, xw(?)

ESSF: xc (one location?), xcp (one location)

ICH: dw(?), mk (infrequently), xw(?)

IDF: dk (several locations), dm (infrequently), mw(?), ww(?), xh, xw

MS: dm (one location), xk

PP: dh, xh

Broad ecosystem units

Hibernacula:

AB, BS, CL, DF, DP, PP, RO, SS, TA

Foraging:

AB, AC, BS, CF, CR, DF, DP, IN, LL, LS, ME, MR, MS, OV, OW, PP, RO, SP, SS, TA, WL

Elevation

In British Columbia, rattlesnakes typically occur along valley bottoms and adjacent slopes, typically at elevations below 800 m, although there are anecdotal sightings (unconfirmed) of rattlesnakes as high as 1400 m.

Life History

Diet and foraging behaviour

The Western Rattlesnake primarily hunts small mammals in British Columbia. Most of its prey consists of voles and mice (Macartney 1989), although marmots, shrews, squirrels, chipmunks, pocket gophers, rabbits, and birds are also consumed. Other snakes are also occasionally eaten.

Reproduction

Females mate in late summer while still in summer foraging territories. This increases the likelihood of exchanging genetic material between neighbouring dens. Fertilization is delayed until early the following spring. Females remain near their dens during which an average of five embryos develop internally. Gravid females do not feed for the duration of their pregnancy (Macartney and Gregory 1988). Females appear to only breed every third year in British Columbia (Macartney 1985). Young are born live in late August and early September. Mortality of neonates through their first winter period ranges widely (24–100%) and can be quite high (Macartney 1985; Charland 1989).

Site fidelity

Western Rattlesnakes exhibit strong fidelity to hibernacula and seasonal foraging areas (Macartney 1985; Charland et al. 1993). It appears that when areas are developed near hibernacula, most perish in these areas but individuals that have territories away from the development persist. If hibernacula are destroyed when snakes are not present, it is generally believed that most individuals will be unable to find suitable hibernacula elsewhere and perish as winter approaches.

Home range

Western Rattlesnakes establish home ranges that are re-used in subsequent years (Macartney 1985). In British Columbia females are known to typically have smaller home ranges than males. Females typically remain within 500–1000 m of the den. Males have slightly larger home ranges and will move 1000–1500 m from the den (J. Hobbs, pers. comm.)

Movements and dispersal

Rattlesnakes spend winters (about 180 days, or more in cooler parts of their range) in hibernacula (dens) that have been used for generations. Rattlesnakes emerge from dens in March through April. A considerable amount of time is spent basking at den entrances prior to dispersal. The remainder of spring is spent on warm aspect slopes, due to thermoregulatory requirements. As the weather warms, rattlesnakes will move to more densely vegetated areas such as riparian habitats, to avoid excessive heat. Travel corridors are often followed when moving between dens and adjacent foraging areas. These usually consist of vegetated gullies, ravines, and similar terrain features that are suspected to provide enhanced cover opportunities for dispersing snakes (J. Hobbs, pers. comm.). Individuals seek cover objects throughout the active season. Fall retreat to dens is rapid at the onset of cooler temperatures. Virtually all of the snakes have returned to the hibernacula by mid-October. Seasonal movements seldom exceed 1.5 km from hibernacula in British Columbia (see "Home range" above) (Macartney 1985; Bertram et al. 2001).

Habitat

Structural stage

There are no structural stage preferences known for this species. Any influence of structural stage on foraging may be subtle and related to the production of prey.

Important habitats and habitat features

Hibernacula

Hibernacula are the most critical habitat features for Western Rattlesnakes. Hibernacula provide refugia from the extreme cold of winters. Hibernacula are used by many individuals and for many generations. Hibernacula are most commonly found near the base of rock outcroppings within large areas of coarse talus, usually in very deep fissures. Occasionally talus slopes or very coarse glaciofluvial material are used for denning (Sarell 1993). Warm aspects are usually used (e.g., east through northwest), as they provide longer solar exposure (relative to cool aspects). Prolonged exposure to the sun enhances heat absorption within the denning material; for similar reasons, exposed slope positions may also be preferred. The distribution of suitable hibernacula probably influences the distribution and viability of local populations.

Foraging

Grassland, parkland forest, wetland, and riparian areas provide foraging habitat for Western Rattlesnakes. Foraging habitats must also provide suitable cover, in the form of vegetation and coarse woody debris, to provide protection from predation and to enable the snakes to forage successfully by using cover for concealment.

Conservation and Management

Status

The Western Rattlesnake is on the provincial *Blue List* in British Columbia. Its status in Canada has not been determined by COSEWIC but will be considered during the winter of 2002–2003 (COSEWIC 2002). The NatureServe currently only ranks the Western Rattlesnake at the species level as *Crotalus viridis*; thus, the NatureServe ranks may not adequately reflect the level of risk of *Crotalus oreganus*.

Summary of status for *Crotalus viridis* in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	WA	OR	Canada	Global
S3	S5	S5	S4	N3N4	G5

Trends

Population trends

Population trends have not been studied in the province; however, extirpation of populations has been documented (Sarell 1993). All researchers strongly suspect that populations are declining rapidly throughout the settled portions of their range, although, declines have been greatest in the Okanagan and Kamloops areas.

Habitat trends

Western Rattlesnakes generally hibernate and forage in the lower portions of the main valleys in the southern interior of the province. These areas are also under the greatest threat from urban, industrial, and agricultural development. Road construction and expanded traffic may be the greatest intrusion into habitats throughout their range. Talus extraction also significantly impacts habitats. In the late 1980s it was calculated that about 10% of ecosystems in the south Okanagan remained relatively undisturbed (Redpath 1990). Most of this area would have at one time provided suitable habitat for Western Rattlesnakes. Some populations are protected on conservation holdings of the federal, provincial, and non-government agencies. Many other dens occur on Indian Reserves, provincial forests, and private lands.

Threats

Population threats

Roadway mortality is probably the leading cause of ongoing mortality in rattlesnakes. Entire populations can be extirpated if the den is destroyed. Localized land developments and linear corridor construction can decimate local populations. Mortality also occurs from domestic animals (e.g., cats, dogs), livestock, and direct persecution by humans. Klauber (1972) reported that cattle inadvertently trample rattlesnakes and that there are at least several reliable observations of cattle deliberately stomping on rattlesnakes until the rattlesnake was dead. Domestic animals that have frequent encounters with rattlesnakes are much more likely to kill snakes than those that are unfamiliar with them (Klauber 1972).

Habitat threats

The greatest threats to habitats are from the conversion of natural lands (Cannings et al. 1999) for agricultural or residential developments and from quarrying/mining and the construction of linear corridors. Roadways may disturb narrow corridors but create lethal obstructions for travelling snakes in otherwise suitable habitat. Heavy livestock use likely effects the survivorship and density of rattlesnakes through the loss of cover. Heavy livestock use may also influence the abundance of suitable prey (MELP 1998). Reduction of available cover from heavy grazing within the summer range or near the den could potentially affect mortality rates within the population by increasing their exposure to predators (Hobbs and Sarell 2000, 2001; Hobbs 2001; G. Schuett, pers. comm.; A. Didiuk, pers. comm.; K. Larsen, pers. comm.).

Legal Protection and Habitat Conservation

The Western Rattlesnake is protected in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act*.

A number of dens occur within protected areas including Okanagan Mountain Provincial Park, Kalamalka Provincial Park, Haynes Lease Ecological Reserve, White Lake Protected Area, Kobau Provincial Park, as well as other areas managed for conservation (e.g., Nature Trust of BC). However, much of the range of this species occurs on Crown land, private land, or Indian Reserves.

This species' habitat requirements may be partially addressed by the results based code riparian and range recommendations.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- Maintain and maximize connectivity between hibernacula and foraging habitats.

Wildlife habitat area

Goal

Maintain and link denning and foraging habitat, travel corridors, and egg-laying sites within and between adjacent populations.

Feature

Establish WHAs at communal dens, especially for multi-species dens, and talus slopes, rock outcrops, or cliff habitats identified to be important for the conservation of this species.

Size

Approximately 200–300 ha but will depend on site specific factors such as area of suitable habitat, nearness to foraging areas and egg-laying sites.

Design

The boundaries of the WHA should be designed to include and connect den sites, travel corridors, egg-laying sites, and important foraging areas.

General wildlife measures

Goals

1. Minimize disturbance and mortality, particularly road mortality.
2. Maintain critical structural elements such as rock outcrops, talus slopes, friable soils, coarse woody debris, friable soils, concentrations of boulders, or other unconsolidated materials and vegetative cover.
3. Maintain microclimatic conditions of hibernacula.
4. Maintain moderate to dense cover to conceal snakes and maintain foraging opportunities.
5. Maintain riparian areas in a properly functioning condition.

Measures

Access

- Place roads as far as practicable from hibernacula and known snake travel corridors. Avoid construction between April and October when snakes are active. When recommended by MWLAP, rehabilitate temporary access roads immediately after use or gate less temporary roads to reduce traffic.
- Where determined to be necessary by MWLAP, use snake drift fences and drainage culverts at intersections of roads and known travel corridors. Drift fences should be ≥75 cm high. Length will vary by site depending on area used by snakes. Consult MWLAP for more information. Seasonal use restrictions may be appropriate for some roads.
- Do not remove or disturb rock or talus.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing (e.g., timing, distribution, and level of use) to prevent trampling and maintain suitable vegetative cover (i.e., >15 cm height in upland areas; >10 cm height in riparian areas).
- Do not concentrate livestock within 200 m of den site during spring dispersal (March/April) and fall (September/October) aggregations. Do not place livestock attractants or corrals within 200 m of den site. Do not trail livestock within 200 m of den site during spring and fall aggregations. When hay cutting or prescribed burning is planned, consult with MWLAP for the preferable times (i.e., after snakes have returned to dens).

Recreation

- Do not establish recreation sites within WHA.

Additional Management Considerations

Use the maximum cut height when hay cutting. Check cut hay for snakes prior to baling.

Where migration routes from denning locations to summer habitats have been transected by roads, use methods such as drift fences, culverts, or seasonal road restrictions to allow the safe passage of snakes.

Rock climbing should be considered a disturbance at sensitive sites.

Riparian areas adjacent to WHAs should be managed or restored to ensure foraging habitat is maintained.

Avoid converting areas adjacent to WHA to an early seral grassland condition. Early seral stages may have less cover for concealing snakes from predators and they may experience greater threats from trampling due to higher livestock pressures.

Information Needs

1. Identification of hibernacula and their characteristics.
2. Dispersal behaviour (e.g., travel corridors) from dens.
3. Influence of grazing and cover reduction on predation levels.

Cross References

Bighorn Sheep, Fringed Myotis, "Great Basin" Gopher Snake, Prairie Falcon, Racer, White-headed Woodpecker

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Birds

Burrowing Owl

Athene cunicularia

Original prepared by Ernest E. Leupin

Species Information

Taxonomy

The Burrowing Owl belongs in the monotypic genus *Athene* (AOU 2002). There are 18 recognized subspecies in North and South America (Clark et al. 1978) of which two occur in North America: *A. cunicularia. floridana*, found in Florida, the Bahamas, and other Caribbean islands and *A. cunicularia hypugaea*, found throughout Mexico, western United States, and southwestern Canada (Cannings 1978).

Description

Small owl (23–28 cm) with round head lacking ear tufts; yellow eyes; body is dull brown with pale bars and spots; underside and breast are lighter and barred with brown; white-barred on tails and wings. Tail is short and wings are large. Males and females have a similar appearance.

Distribution

Global

The western subspecies (*A. cunicularia hypugaea*) is found from Canada to Panama. In Canada, it occurs in Manitoba, Saskatchewan, Alberta, and British Columbia.

British Columbia

In British Columbia, Burrowing Owls were historically found north to Kamloops, west to Ashcroft, and east to the Purcell Mountains, with populations in the Fraser River Delta (Hjertaas et al. 1995; Campbell et al. 1990). There are historical breeding records of wild birds in Creston, Merritt, Cache Creek, Kamloops, and the Lower Mainland. At present, the Burrowing Owl is confined to areas within the Thompson-Okanagan Plateau (D.J. Low, pers. comm.). In the 1980s and 1990s, reintroductions efforts took place in Oliver, Merritt, Cache Creek, and Kamloops. Released populations are concentrated in four main areas in the Thompson-Nicola Region: Lac du Bois Grasslands, Knutsford, Hamilton Commonage, and Quilchena.

The current extent of wild populations in British Columbia is mostly unknown. There are consistent reports of Burrowing Owls near Merritt, which suggest the existence of a small remnant population in the area. In all other areas, reports of wild Burrowing Owls are sporadic and isolated and thus cannot be considered as breeding populations. The occurrence of unbanded birds at release sites may indicate the presence of wild birds in the area, or could simply be progeny from released birds that were missed during previous banding efforts.

Non-breeding records have been made in the Beaver Valley west of Horsefly, Delta, Nanaimo, Campbell River, and the west Kootenays, although these are believed to be accidental events.

Forest region and districts[1]

Southern Interior: Cascades, Kamloops, Okanagan Shuswap (Penticton)

Ecoprovinces and ecosections

CEI: FRB (non-breeding)

GED: FRL, NAL (non-breeding)

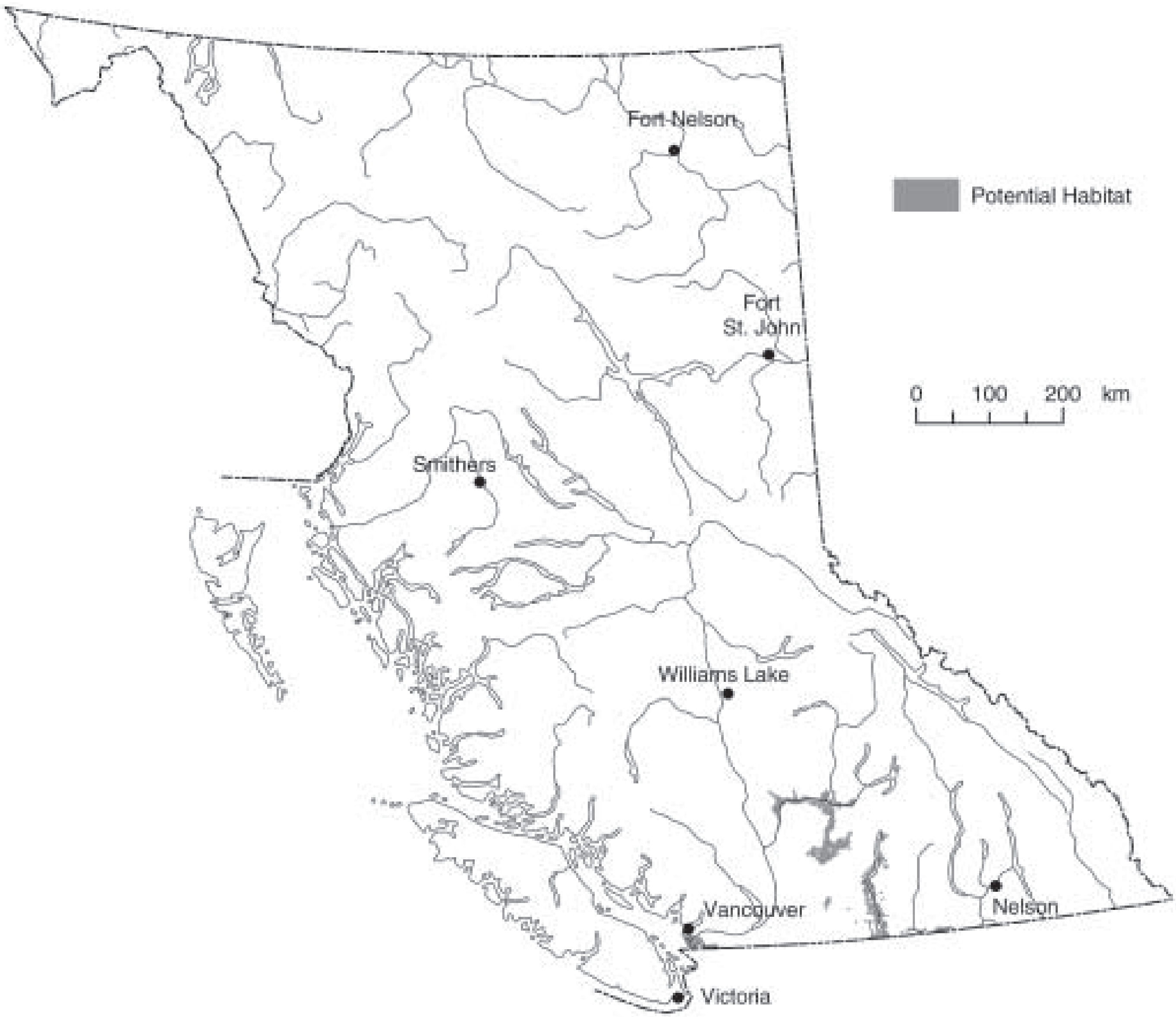
SIM: EKT (non-breeding)

SOI:[2] NIB, NOB, NOH, OKR, SOB, SOH (breeding), STU, THB

1 Current breeding distribution.

2 Breeding in SOI only.

Burrowing Owl
(Athene cunicularia)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Biogeoclimatic units

BG: xh1 (NOB, OKR, SOB), xh2 (THB), xw1 (NIB, THB), xw2 (FRB), xw3

CDF: mm (FRL, NAL)

IDF: dk1a (NIB, STU), xh1a (NOB, OKR, STU), xh2a (NIB, THB), xm (FRB)

PP: dh1 (SOH), xh1 (NOB, SOB), xh1a (NOB, OKR, SOB), dh2 (EKT)

Broad ecosystem units

BS, SS, (CF, ES on the coast)

Elevation

335–1250 m

Life History

The following life history information is specific to the western subspecies with emphasis on populations in Canada and North American prairie populations. Because detailed life history observations for wild birds in British Columbia are scarce, the data presented for British Columbia owls reflect observations made from captive-bred and released individuals in the Thompson-Nicola region unless otherwise indicated.

Diet and foraging behaviour

Burrowing Owls are opportunistic predators (Wellicome 1997; Leupin et al. 2000), preying primarily on insects and small mammals (Plumpton and Lutz 1993). During the day, owls prey on insects near the burrow; whereas, foraging for small mammals occurs predominately at night. For British Columbia's released population, small mammals comprised approximately 55% of the biomass in their diet and this proportion varied little throughout the year. In contrast, invertebrate prey consumption reflected the seasonal availability of the various species (Maser et al. 1971; Dickinson et al. 1994). Owls consumed coleopterans almost exclusively during the spring and early summer, but gradually shifted to grasshoppers as the season progressed. The diet of released owls is similar to that observed in wild populations (Leupin et al. 2000).

Several studies have identified small mammals as an important prey base for Burrowing Owls (Hjertaas et al. 1995). Vertebrate prey appear to be limiting during brood rearing (Wellicome 1997), which suggests that productivity is limited by low population levels of small mammals.

Reproduction

Owls return to breeding areas in April and May (Wellicome 1997; Leupin and Low 2000). In western North America, Burrowing Owls do not dig their own burrows, but rather occupy burrows made by fossorial mammals. Burrows are typically modified by enlarging burrow diameter and nest chambers (Coulombe 1971). Males choose a suitable burrow and advertise for females by calling. Burrows used by owls in British Columbia include those dug by Badger (*Taxidea taxus*), Coyote (*Canis latrans*), and Yellow-bellied Marmot (*Marmota flaviventris*) (Howie 1980; Bryant 1990). Nesting burrows and entrances are lined with cow manure chips prior to egg laying. The lining of burrows with manure is believed to be an evolutionary strategy to reduce predation by masking their scent to avoid detection (Coulombe 1971; Wellicome 1997).

Egg laying in wild populations typically begins in late April–late May (Coulombe 1971; Haug 1985). In British Columbia's captive bred/released populations, releases are purposely delayed to minimize mortality of released owls by migrating raptors. As a result pairing and nesting typically occurs between May and July (Leupin et al. 2000).

Mean clutch size for wild populations is between 3.6 (Plumpton and Lutz 1998) and 8.3 (Olenick 1987). Mean clutch size in released populations in British Columbia is 5.6 (Leupin et al. 2000). Young hatch after 21–30 days of incubation and emerge from the nest 20–25 days later. Fledglings begin moving between burrows shortly thereafter. Mean brood size for wild populations ranges between 2.1 and 6.3 (Hjertaas et al. 1995). In released populations in British Columbia, the mean brood size is 4.1 (Leupin et al. 2000).

Site fidelity

Philopatry and nest-site fidelity in Burrowing Owls is poorly understood. In Colorado, Plumpton and Lutz (1998) found that 92% of banded owls were never re-encountered the year following banding. However, a large proportion of the birds that returned (75% males and 63% females) occupied formerly used sites.

Home range

Home range for radio-collared males averaged 2.41 km^2 (range 0.14 km^2–4.81 km^2) in a foraging study near Saskatoon in 1989; although 95% of all detections were made within 600 m of the nest site (Haug and Oliphant 1990). A study conducted in southern Saskatchewan in 1997 reported significantly smaller home ranges (average 0.35 km^2, range 0.08 km^2 –0.49 km^2) (Sissons et al. 1998). The small home ranges observed were thought to have resulted from a superabundance of small mammals in the Canadian Prairies in that year (Wellicome et al. 1998).

In British Columbia, released captive-bred radio-collared males ($n = 2$) were observed mostly within 300 m of the nest site. Hunting movements were made at approximately 1 hour intervals and the average distance was 800 m (range 200–1500 m) (Leupin, unpubl. data).

Although this species has a clustered distribution, intra-specific competition has been reported if nests are too close (<110 m) (Hjertaas 1990). For released owls in British Columbia, the average distance between selected nesting burrows is 200 m and no territorial conflicts have been observed (D.J. Low, pers. comm.). One wild male was observed chasing off two released males at a release site where two captive-bred females were present (D.J. Low, pers. comm.).

Dispersal and migration

Juveniles disperse soon after fledging. Movements and distance away from the natal burrow increase in frequency and distance over time (Clayton 1997). Migration of birds from British Columbia typically occurs in September and October (Leupin et al. 2000); however, some of the released owls in British Columbia have remained over winter at, or near, release sites (Leupin et al. 2000).

Migration routes and areas used for overwintering are for the most part unknown (Wellicome 1997). Banded birds from Alberta and Saskatchewan have been relocated in Texas and Northern Mexico (G. Holroyd, pers. comm.). There are three recovery records (one each from Washington, Oregon, and California) for released birds banded in British Columbia. These recoveries suggest that B.C. owls use migration routes through the Great Basin in Washington and Oregon and into the southern coastal plain region of California (Leupin et al. 2000). However, these results should be interpreted with caution as they are from captive-bred birds and may not represent natural population's migration patterns.

Habitat

Structural stage

1: non-vegetated/sparse
2: herb

Important habitats and habitat features

Nesting

Important habitats include short grass, sparsely vegetated areas with available burrows in which to nest, as well as densely-vegetated areas adjacent to nesting areas to supply an adequate prey base (Wellicome 1997). In British Columbia, Burrowing Owls are associated with communities dominated by big sagebrush (*Artemisia tridentata*), antelope-brush (*Purshia tridentata*), and bunchgrass (*Agropyron* and *Festuca* spp.).

In the North American prairie, nesting habitat is strongly associated with ground squirrel (*Spermophilus* spp.), Black-tailed Prairie Dog (*Cynomys ludovicianus*), Yellow-bellied Marmot, Badger, Red Fox (*Vulpes vulpes*) and Coyote burrows and dens (Wellicome 1997; Desmond and Savidge 1998). In British Columbia, burrow availability is considered a limiting factor for this species.

Nest locations are usually located in areas where vegetation is shorter and less dense than the surrounding landscape (Green and Anthony 1989). Green and Anthony reported nest locations in areas with short grass (0–10 cm) and weedy herbaceous species. Short grass is preferred perhaps because it enables the detection of predators, or because of availability of invertebrate prey.

Foraging

Burrowing Owls forage in a variety of habitats; however, foraging habitat close to the nest is important. Insects are taken from sparsely vegetated areas near the nest burrow (Wellicome 1997). Foraging for small mammals occurs in areas that are more densely vegetated. Haug and Oliphant (1990) found that nocturnal foraging was concentrated in roadside ditches, uncultivated fields, and ungrazed fields where taller vegetation prevailed. In British Columbia, released owls were observed foraging in a similar fashion. Night foraging was carried out mostly along riparian areas in ephemeral ponds and moisture seepage sites, and to a lesser extent along the sides of gravel roads.

Conservation and Management

Status

The Burrowing Owl is on the provincial *Red List* in British Columbia. Originally designated as *Threatened* in Canada (COSEWIC 1978), it is now considered *Endangered* (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

Population declines of the western subspecies have been reported throughout most of its range including serious declines in Canada (Holroyd 1998) and many parts of the United States (G. Holroyd, pers. comm.). A survey of 19 U.S. state wildlife agencies in 1992 reported declines in nine states; none reported increases (James and Espie 1997). In 1998, California reported the disappearance of 60% of known breeding groups initially reported in 1980 (Barclay et al. 1998). Texas also reported a 58% decline between 1990 and 1996 (Desmond and Savidge 1998).

In Canada, declines are well documented (Wellicome 1997). Generally, the population appears to be declining at a rate >10% annually (Holroyd 2000). In 2000, the population estimate for Alberta and Saskatchewan is 1000 pairs (Holroyd 2000). The rate of the decline in the last two decades has been sharp. Alberta reported declines from 1500 pairs in 1978 to 842 pairs in 1996 (Wellicome 1997). Significant declines were also reported in Saskatchewan from a program that relies on rural landowners to report Burrowing Owl sightings on their land. In 1988, 232 landowners reported 721 pairs whereas 485 landowners reported only 88 pairs in 1997 (Operation Burrowing Owl). In 1977, Manitoba's population was estimated at 100. In 2000, no pairs were reported and the species is now considered effectively extirpated (De Smet, pers. comm.).

In British Columbia, historical information suggests that Burrowing Owls were a regular breeding species. However, reports of wild breeding populations have

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	CA	ID	MT	OR	WA	Canada	Global
S1B, S2N	S2B, S2N	S2	S3S4	S3B, S2N	S2B	S3B S2N	N2B	G4

not occurred since 1996. Reports of naturally occurring breeding pairs are a rare occurrence and the species was considered extirpated in British Columbia (Fraser et al. 1999). In 1989, a captive breeding and release program was initiated to reintroduce Burrowing Owls into historical sites. Since the inception of the reintroduction program, a total of 208 owls have been released (average = 26 birds per year). Ten years of reintroduction efforts of captive bred owls have not resulted in a self-perpetuating population.

Habitat trends

The general concern for Burrowing Owl populations in British Columbia is the availability of suitable grassland habitat. Grasslands make up <1.5% of the total land area in British Columbia (Chutter 1997). Suitable habitat for Burrowing Owls in British Columbia has declined. Native grasslands have been converted to agricultural crops, orchards, and urban areas, and remaining habitats are highly fragmented. However, some areas near Kamloops where crops were historically grown have been reverted to native grasslands. In addition, ground squirrel control programs have reduced burrow supply.

The historical diversity of vegetation, prey base, and symbiotic fossorial mammals is no longer sufficiently represented on the provincial landscape in a manner that satisfies the life-requisite needs of the Burrowing Owl (D.J. Low, pers. comm.).

Threats

Population threats

The sources of direct mortality include insecticide and rodenticide use, predation, vehicular collisions, and shooting (Wellicome 1997). The relative impacts of each can vary considerably between locations.

Insecticides can cause adult and juvenile mortality and affect reproductive performance because target species are often those that make up a significant portion of the owl's diet. In Saskatchewan, exposure to carbofuran, a systemic insecticide, at nesting sites resulted in a 54% reduction in the number of young produced and a 50% reduction in the proportion of pairs successfully fledging young relative to untreated areas (James and Fox 1987).

Some predator populations have increased considerably since historical times. The increases are believed to be associated with agricultural development. Main predators are Coyote and avian predators. Red-tailed Hawks (*Buteo jamaicensis*) and other raptors have benefited from the creation of perching structures (trees and fences) in grassland systems. In British Columbia, captive bred released birds are highly susceptible to predation during the first week after being released (Leupin and Low 2000).

Vehicular collisions also contribute to mortality, although the magnitude of the problem is difficult to assess. Wellicome (1997) suggested that the effects of vehicle mortality on Burrowing Owl populations in Alberta are low. However, the effect of vehicular collisions may be significant in areas where traffic is heavier or areas with higher road densities. In British Columbia, vehicular collisions do not appear to be of significance. Of 220 owls released since 1992, only one death is known to be from a vehicle collision.

Although mortalities associated with shooting do occur, they are difficult to quantify. Most shootings are likely accidental, as Burrowing Owls can easily be mistaken for ground squirrels or prairie dogs at a distance. Shootings are believed to be infrequent and of little effect to the overall population (Wellicome 1997).

Habitat threats

Elsewhere in their breeding range, the threats to this species have been clearly outlined (Hjertjaas et al. 1995; Holroyd 1998). In British Columbia, there is little supporting literature that details the factors responsible for decline (but see Howie 1980 and Bryant 1992). It is likely that the threats to Burrowing Owls in this province are commensurate with those observed elsewhere.

Grassland systems in British Columbia have been lost or fragmented as a result of forest encroachment, urban expansion,, and conversion of native grassland to agriculture (e.g., orchards). In addition to habitat loss and fragmentation, several anthropogenic activities have contributed to the degradation of the remaining habitats. These include burrowing mammal eradication, incompatible grazing regimes, early homestead stone removal from fields in ground squirrel habitats, fire suppression, and noxious weed introduction (Todd 1998; Leupin et al. 2000; D.J. Low, pers. comm.). These activities have contributed to decreases in burrow availability, loss of horizontal vegetation heterogeneity, decreases in vertebrate prey base, and increased predation, all of which contribute to elevated mortality rates (D.J. Low, pers. comm.). Howie (1980) identified the reduction in Badger populations as a main factor responsible for the Burrowing Owl decline.

Legal Protection and Habitat Conservation

Raptors are not covered by the federal *Migratory Bird Convention Act*. In British Columbia, the Burrowing Owl is designated as an Endangered Species under the *Wildlife Act*. It is one of a few species listed in Section 34b of the *Act* for which the nest is protected year-round, regardless of whether it is active.

Due to the Burrowing Owl's national status, a national recovery team was established to direct research and conservation activities towards downlisting the species in Canada. A recovery team was also established in British Columbia. The BC Recovery Team has forged strong working relationships with range landowners to promote Burrowing Owl habitat stewardship. The commitments made by local landowners ensure habitat availability and sustainable management strategies that incorporate habitat requirements of the Burrowing Owl. These commitments are verbal and are not legally binding. Unless covenant documents are prepared on private lands, the commitment to protect Burrowing Owl habitat may not provide for long-term protection of the habitat.

Only a small proportion of existing Burrowing Owl habitat is under Crown ownership. Some habitat occurs within protected areas such as the Lac du Bois Grasslands Provincial Park and the Osoyoos Desert Centre. Range use plans under the results based code (RBC) may provide some degree of habitat conservation on Crown land, provided these plans contain objectives and strategies for maintaining important habitat features outlined in this account (see below).

Current legislated protection and protected areas have resulted in relatively small, fragmented habitat pockets that are embedded in a larger matrix of privately owned properties; the latter not being subject to RBC guidelines. Despite extensive research and recovery efforts, as of yet no effective management measures have been proven to stabilize or increase Burrowing Owl population numbers in British Columbia.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- ❖ Consider fossorial mammals and availability of suitable burrows. Protection of grassland habitat is not sufficient unless burrows are available.
- ❖ Maintain connectivity of grassland habitats by managing and protecting remnant habitats throughout the Great Basin.
- ❖ Ensure long-term availability of suitable habitats through management strategies aimed at increasing burrowing mammal populations.
- ❖ Within sites maintain a mosaic of grassland habitat in a variety of structural stages.

Wildlife habitat area

Goal

Maintain or recover nesting and foraging habitat for Burrowing Owls in appropriate juxtapositions.

Feature

Establish WHAs at active nest sites as recommended by the Burrowing Owl Recovery Team.

Size

Roughly 300 ha but will depend on site-specific factors, such as habitat suitability and number of breeding pairs.

Design

WHAs should include the nest site (burrow), roost burrows, and approximate home range. Based on home range studies, an area of 1000 m radius around the nest site is recommended (Haug and Oliphant 1990; Sissons et al. 1998). Where more than one family occurs in close proximity, the WHA should be centred on all nest locations and the total area increased to at least 490 ha (1250 m radius).

The WHA should be designed to prevent disturbance to the nest sites but should also contain important areas for foraging (e.g., tall grass areas and riparian areas without trees or large shrubs).

General wildlife measure

Goals

1. Prevent physical damage to burrows.
2. Maintain both nesting and foraging habitat structure and critical features (i.e., ground cover and tall grass for prey species as well as short grass areas for nesting Burrowing Owls).
3. Minimize disturbance to nesting sites.
4. Minimize road mortality.
5. Minimize threat of predation.
6. Prevent forest encroachment.

Measures

Access

- Restrict vehicular access within 500 m of nest sites during the breeding season (1 April to 31 July). Limit all vehicular access year-round within 150 m of known nest locations.
- Do not construct roads or trails.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to maintain desired structure of plant community, desired stubble height, and browse utilization. If damage from livestock is found to be degrading vegetative structure, fencing may be required. Consult MWLAP for fencing arrangements.
- Do not graze during the breeding season (1 April through 31 July).
- Do not concentrate livestock within WHA.
- Maintain tall grass structure in areas designated to provide foraging habitat.
- Maintain dense understorey with sufficient residual cover suitable for small mammals in riparian areas through methods such as placement of salt licks, water developments, fencing, or herding.
- Do not mow during the breeding season (April through July).

Recreation

- Do not develop recreational sites or trails.
- Do not use recreational vehicles (i.e., off-road vehicles) within WHA.

Additional Management Considerations

Where possible, control forest encroachment into natural grassland habitat with controlled prescribed burning. Fall burning or manual removal of seedlings and saplings is preferred in Burrowing Owl WHAs.

The current shortage of burrows has resulted from the historical reduction of fossorial mammal populations in the southern Interior of British Columbia. Currently, artificial burrows (nesting and security) are placed in areas containing suitable nesting and foraging habitats. Although artificial burrows are an effective short-term enhancement technique, they should not be considered an ultimate solution (Bryant 1990). Yellow-bellied Marmot (*Marmota flaviventris*), Columbia Ground Squirrel (*Spermophilus columbianus*), and Badger (*Taxidea taxus*) are three native fossorial species that still persist, albeit in low numbers, in British Columbia's grasslands. Therefore, any management activities that benefit these populations will ultimately be beneficial to Burrowing Owls.

Despite intensive efforts to determine the reasons for the decline of Burrowing Owl populations, no significant positive changes have been achieved to permanently increase populations of Burrowing Owls in Canada. Return rates for banded owls are relatively low (Hjertaas 1992), which suggest that mortality rates during migration and wintering may be an important factor for Canadian populations. International efforts to ensure winter and migration habitat availability should become a priority to complement recovery efforts in British Columbia and other Canadian provinces.

Information Needs

1. Migratory routes.

Cross References

Badger, "Columbian" Sharp-tailed Grouse, Great Basin Spadefoot, Long-billed Curlew, Western Rattlesnake

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Flammulated Owl

Otus flammeolus

Original prepared by R.J. Cannings and Astrid M. van Woudenberg

Species Information

Taxonomy

The Flammulated Owl is the only New World *Otus* species that is part of the Old World subgenus *Scops* and is not closely related to other North American *Otus* species. One to six subspecies are recognized (Hekstra 1982; del Hoyo et al. 1999). Populations at the northern range, including those in British Columbia, are generally separated as *O. flammeolus idahoensis* (e.g., Cannings 1998), although the species is sometimes treated as monotypic (e.g., del Hoyo et al. 1999). Geographical differences include the amount of reddish pigment in the plumage (increasing southward with increasing pine dominated habitats; conversely, increasing grey with increasing Douglas-fir heading north) and wing length (increasing northward with increasing migration distances), although the differences may be clinal and not useful for subspecific taxonomy (del Hoyo et al. 1999).

Description

Small owl (16–19 cm in length) with variegated red and grey plumage. Small indistinct ear tufts. Brown eyes.

Distribution

Global

The Flammulated Owl breeds in the western mountains of North America from British Columbia south to Mexico and northern Central America. In winter, populations in Canada and the United States migrate to the southern portions of the breeding range (McCallum 1994a).

British Columbia

In the breeding season (May–September), the Flammulated Owl occurs from the Okanagan and Similkameen valleys north through the Nicola and Thompson valleys and the drier parts of the Fraser-Chilcotin valleys to Alexis Creek in the west and McLeese Lake in the north (Roberts and Roberts 1995; Waterhouse 1996, 1997; K. Wright, pers. comm.). It is also found in the Rocky Mountain Trench north at least to Radium Hot Springs.

The species occurs in the elevational band characterized by dry Douglas-fir (*Pseudotsuga menziesii*) forests along the upland slopes of the major drainages of the southern region of the province. Confirmed records are from the Fraser River between Williams Lake (M. Waterhouse, pers. comm.) and Lytton (Texas Creek) (van Woudenberg 1998); North Thompson Valley (Christie 1996; Christie and Low 1996); Merritt, Princeton, and Nicola valleys (van Woudenberg and Christie 2000); South Thompson and Okanagan valleys (Cannings and Booth 1997); and the southern Rocky Mountain Trench to Radium Hot Springs (CDC 1998; van Woudenberg et al., in prep.).

Forest region and districts

Southern Interior: 100 Mile House, Cascades, Central Cariboo, Chilcotin, Kamloops, Okanagan Shuswap, Rocky Mountain

Ecoprovinces and ecosections

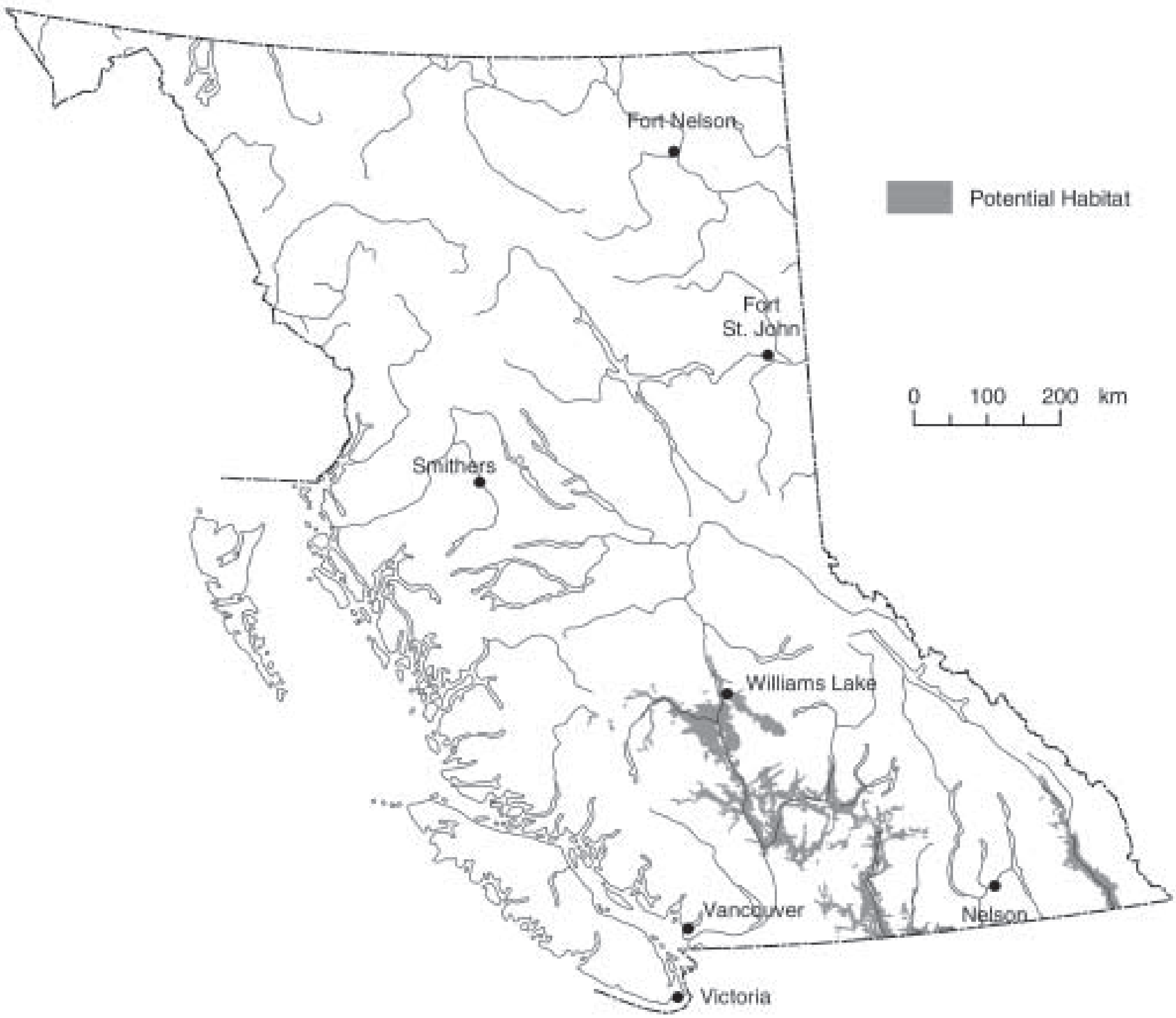
CEI: CAB, CCR, CHP, FRB, QUL

SOI: GUU, NIB, NOB, NOH, NTU, OKR, PAR, SCR, SHB, SOB, SOH, STU, THB, TRU

SIM: EKT, EPM, MCR, UCV

Flammulated Owl

(Otus flammeolus)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Biogeoclimatic units

BG: xh1, xh2, xw, xw1, xw2

PP: dh1, dh2, xh1, xh2

IDF: dk1, dk2, dk3, dk4, dm, dm1, dm2, mw1, mw2, un, xh1, xh1a, xh1b, xh2, xh2a, xh2b, xm, xw, xw2

Broad ecosystem units

DF, DP, PP

Elevation

North America: 375 (Campbell et al. 1990)–2700 m (Winter 1974)

British Columbia: Kamloops and Merritt 400–1375 m (van Woudenberg et al. 1995)

Life History

Diet and foraging behaviour

Insectivorous. Prey consists of larger insects, including moths, katydids, crickets, and beetles, often taken on the wing from high grass or shrubs in forest openings, or gleaned from forest canopies.

Reproduction

Breeds in British Columbia between May and August. Generally, one clutch is laid per year. Clutch size is typically two to four eggs; young may fledge from mid-July through mid-August; fledglings depend on parents for 4–5 weeks.

The Flammulated Owl is a secondary cavity nester, nesting in natural cavities or those excavated by Pileated Woodpeckers (*Dryocopus pileatus*) or Northern Flickers (*Colaptes auratus*) (van Woudenberg 1999). Alternative cavities have been used for nesting in the same tree in successive years and alternative trees have been used within the same foraging areas. The Barred Owl (*Strix varia*) is a significant predator in some localities, and may be a particular risk to Flammulated Owl fledglings.

Site fidelity

This species shows strong fidelity to breeding areas (Reynolds and Linkhart 1992). Males typically return to territories.

Home range

Home range size and dispersal behaviour of Flammulated Owls are not well understood in British Columbia, although foraging distances have been as far as 586 m from nest sites. Home range areas have been recorded as large as 15.9 ha on average (McCallum 1994b); however, 2.2–3.7 ha were roughly estimated for two nest sites in British Columbia (van Woudenberg 1992).

Dispersal and movements

Often forages within 300 m of nest site during breeding season.

Neotropical migrant. Winters in Mexico and northern Central America (McCallum 1994a).

Habitat

Structural stage

6: mature forest
7: old forest

Important habitats and habitat features

Nesting

Important nesting habitat includes multi-age class stands with multiple canopy layers, including a veteran tree component for nesting and roosting. Wildlife trees with large live branches (class 1) provide considerable security cover for roosting, calling, and snags with cavities (wildlife tree classes 3–6) provide nesting habitat. Occasionally, nests can be found in class 7 wildlife trees, particularly if the tree species is ponderosa pine (*Pinus ponderosa*); however, successful recruitment of young is unknown. Regenerating thickets of Douglas-fir provide security cover if they are adjacent to grassy or shrub-dominated openings that provide foraging habitat. Flammulated Owls do not occupy pre-commercially thinned stands or areas where silvicultural treatments leave evenly spaced, open stands, probably because even-aged, single canopy layer stand structure does not provide the density required for security cover (van Woudenberg 1999).

Recruitment of large diameter ponderosa pine for nest trees may be critical for sustainability of local populations. Large diameter pine tend to be more stable as snags than smaller trees and other species, and may enhance productivity if predation of nests is reduced by high cavities in smooth, hard snags with no bark. Flammulated Owls selected large diameter ponderosa pine disproportionately to Douglas-fir for nesting (van Woudenberg 1992; Christie and Low 1996).

In Oregon, Pileated Woodpecker cavities were preferred by Flammulated Owls in comparison with Northern Flicker cavities (Bull et al. 1990). In British Columbia, 67% of the Flammulated Owl nest trees were in ponderosa pine and 28% were in Douglas-fir (van Woudenberg 1999). Of the nest trees studied in Oregon, 91% were dead and in British Columbia, 75% were dead (Bull et al. 1990; van Woudenberg 1999).

Because Flammulated Owls nest in Pileated Woodpecker and Northern Flicker cavities, it is useful to consider the nesting requirements of these two species in forests where Flammulated Owls occur (see Appendix 12).

Pileated Woodpeckers in northwestern Montana selected mainly western larch (*Larix occidentalis*) and rarely Douglas-fir for nest trees (McClelland and McClelland 1999). They used ponderosa pine where groves were almost entirely composed of ponderosa pine and Douglas-fir. In riparian forests, nest trees were in large black cottonwood (*Populus balsamifera*) and all aspen (*Populus tremuloides*) nest trees were in monospecific groves of aspen (McClelland and McClelland 1999). In the Okanogan National Forest, Northern Flickers selected ponderosa pine and western larch in greater proportion than Douglas-fir or other species (Madsen 1985). In south-central British Columbia, Pileated Woodpeckers nested exclusively in trembling aspen (Harestad and Keisker 1989). Northern Flickers preferred trembling aspen to conifers near Riske Creek (Wiebe 2001).

In British Columbia, the diameter at breast height (dbh) of Flammulated Owl nest trees (n = 11) was 63.8 cm ± 13.5 (after van Woudenberg 1992). The mean dbh varied slightly between tree species, although the range was not dissimilar (Table 1).

Table 1. Dbh (mean ± SD) (cm) of Flammulated Owl nest trees (after van Woudenberg 1992)

Tree species	*n*	dbh	Range
Ponderosa pine	7	65.7 ± 12.8*	46.2–81.2
Douglas-fir	4	60.6 ± 14.6	49–82

* Weighted mean and pooled standard deviation

Nests are often located within and/or near foraging habitat, characterized by small forest openings (<1 ha) adjacent to Douglas-fir thickets and/or large veteran Douglas-firs or ponderosa pines with heavy branching for security.

Foraging

Understorey structure may be important in forest openings for foraging habitat. Flammulated Owls were not observed nesting in areas they had previously occupied after grazing had reduced grasses <10 cm (van Woudenberg 1999).

Conservation and Management

Status

The Flammulated Owl is on the provincial *Blue List* in British Columbia. It is designated as a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	OR	WA	Canada	Global
S3S4B, SZN	S3B, SZN	S3B, SZN	S4B	S3B, SZN	N3B	G4

Trends

Population trends

Current population levels and distribution are poorly known, and since historical populations are completely unknown, trends are difficult to establish. The species is more widespread than previously reported, because of increased search effort in the past decade rather than any real population increase.

The total Flammulated Owl population in British Columbia, including breeders and non-breeders, may be somewhat greater than 3000 birds (van Woudenberg 1999). While minimum population estimates have been refined tremendously over the past 20 years, absolute densities cannot be measured using census results alone, because these only provide minimum numbers of calling birds. Only a nesting pair is clearly indicative of breeding activity and breeding habitat suitability, and relatively few nests have been found. There is thus little information regarding population sizes and no information regarding population trends for the province.

Habitat

Likely declining due to harvesting of old-growth forest and firewood cutting.

Threats

Population threats

The low fecundity of the Flammulated Owl (clutch sizes of two to four) (McCallum 1994b) and its dependence on old-growth features of dry montane forests compound an inherent vulnerability regarding long-term population sustainability.

Habitat threats

The greatest immediate risk to the Flammulated Owl is loss of critical nesting, security, and foraging habitat features from forest management (i.e., harvesting, spacing, thinning, road construction, pest management). A secondary threat is loss of grass and shrub components of foraging habitat by livestock grazing during key breeding periods. In addition, snag removal for safety reasons or for firewood is also a threat. Long-term major threats are recruitment and maintenance of old-growth habitat features, particularly large diameter ponderosa pine snags with cavities. Fire suppression is also a concern as it may reduce foraging habitat over the long term.

Suitable silvicultural treatments and grazing regimes can maintain and encourage regeneration of habitat features.

Legal Protection and Habitat Conservation

The Flammulated Owl, its nests, and its eggs are protected from direct persecution by the provincial *Wildlife Act*.

There are several parks within the range of this species that may contain suitable habitat.

Wheeler Mountain has the highest nesting density of Flammulated Owls documented in British Columbia and is within the Lac du Bois Protected Resource Management Zone (Kamloops LRMP Team 1995). Timber harvesting is not permitted within the protected area but grazing is allowed. There remains the concern that stand structure in the protected area will change without proper management, to the detriment of Flammulated Owl habitat quality. Season-long grazing during the breeding period may reduce current available shrub and grass structure.

The general legal provisions of the results based code, such as wildlife tree retention areas and old growth management areas (OGMAs) provide non-specific protection for forest birds and nesting habitat, including the Flammulated Owl (P. Holman, pers. comm.). Old growth management area considerations for this species could consist of awareness of the preference for ponderosa pine, prescribed treatments may be needed to maintain appropriate stand structure, and grazing should be moderated to maintain grasses >10 cm height on average.

Ungulate winter range provisions likely provide some habitat. Flammulated Owl records in the Cariboo-Chilcotin were completely within ungulate winter ranges (M. Waterhouse, pers. comm., cited by Van Woudenberg 1999).

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Because this species is largely dependent on woodpecker cavities (Northern Flickers and Pileated Woodpeckers) for nest sites, management practices that benefit woodpeckers will also enhance habitat for the Flammulated Owl.

The objective for this species is to maintain wildlife trees and green recruitment trees for nesting across the breeding range and over time. Consider WTR area and OGMA objectives for this species in the following forest districts: Kamloops, Okanagan Shuswap, Cascades, Central Cariboo, 100 Mile House, Chilcotin, and Rocky Mountain. Blocks should be assessed to identify potentially suitable WTR areas. Table 2 provides informaton that should be considered when establishing WTR areas for this species.

As OGMAs are generally larger than WTR areas and are meant to have or obtain old growth features, they may be better suited to the habitat needs of this species.

It is recommended that salvage not occur in WTR areas and OGMAs established to provide habitat for this species. In addition, these areas should be designed to include as many suitable wildlife trees as possible that should be maintained/recruited over the long term (>80 years).

Wildlife habitat area

Goal

Because there are relatively few known nest areas for this species, these sites should be established as WHAs. Suitable habitat should be managed through old forest retention and wildlife tree retention objectives.

Feature

Establish WHAs at known nest sites, occupied breeding territories indicated by detection during the breeding season, or areas with high densities of breeding pairs.

Size

Typically between 10 and 30 ha. Size should be based on estimated home range size using habitat suitability information. High densities may occur within high suitability habitat. Where this occurs, use habitat suitability and home range estimates to determine WHA size.

Design

Design the WHA to minimize disturbance and maintain suitable foraging habitat. The WHA should include a 7–12 ha core area that includes key foraging and security habitats and a ~100 m radius management zone surrounding the core area. The core area should be centred on the nest site when known. The management zone provides adult and fledgling foraging and security habitat. In high density areas, the WHAs may be larger with multiple core areas.

General wildlife measures

Goals

1. Minimize disturbance during the breeding season (1 June to 31 August).
2. Maintain adequate foraging habitat for productivity.
3. Ensure security cover from predators for both foraging adults and fledglings.
4. Ensure WHA is windfirm.

Table 2. Preferred WTP characteristics for the Flammulated Owl

Attribute	Characteristics
Size (ha)	≥4 ha; larger is preferred
Location	PPdh, PPxh, IDFxh, IDFxw, IDFxm, IDFdm, IDFdk, IDFmw
Tree features	visible woodpecker or natural cavities; understorey brush or thickets
Tree species	ponderosa pine; Douglas-fir, possibly trembling aspen or western larch
Tree size (dbh)	64–77 cm; in the absence of trees with the preferred dbh, trees ≥35 cm or largest available should be retained for recruitment
Wildlife tree class	3–7

5. Maintain suitable nesting habitat and surrounding suitable foraging and security habitat (e.g., dry Douglas-fir dominated forests characterized by a mixed-age class, multi-layered canopy, old-growth features, and thickets adjacent to small openings).

Measures

Access

- Do not construct roads. Deactivate or control road access on existing roads.

Harvesting and silviculture

- Do not harvest or salvage within core area except for partial harvesting systems designed to maintain suitable habitat features (i.e., recruitment nest trees; brushy understorey) that will achieve the objective of the general wildlife measures. Treatments should not occur during the breeding season (1 June to 31 August).
- Do not harvest in xeric sites. In the management zone, in mesic or subhygric/hygric sites, use selective harvest methods that retain ≥50% of the dominant or codominant trees of which some should include healthy crowns. Openings should be ≤0.6 ha.
- Retain all ponderosa pine and aspen wildlife trees and all wildlife trees ≥35 cm dbh, using no work zones if necessary.
- Plan for recruitment of ponderosa pine, aspen, and other species into >35 cm dbh class.
- Maintain thickets and veteran trees adjacent to openings.

Pesticides

- Do not use pesticides.

Range

- Manage livestock grazing to retain shrub and grass structure (≥10 cm).

Recreation

- Do not develop trails, roads, or recreation sites within core area.
- Do not cut any wildlife, mature, or veteran trees.

Additional Management Considerations

Post wildlife tree signs to prevent firewood cutting.

Avoid isolating quality habitat patches; maintain some mature, veteran, or thicket component as security linkage. Avoid isolating habitat patches by thinning intervening stands (van Woudenberg 1992).

Within xeric or mesic sites where thickets are continuous, particularly on south, east, or west aspect slopes ≥20%, harvest to create openings ≤2 ha. Encourage ponderosa pine regeneration and understorey shrub development.

Information Needs

1. Post-fledgling habitat needs.
2. Further inventories.

Cross References

White-headed Woodpecker

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"Interior" Western Screech-Owl

Otus kennicottii macfarlanei

Original prepared by R.J. Cannings

Species Information

Taxonomy

The Western Screech-Owl was first described in 1867, but was long considered conspecific with the Eastern Screech-Owl, *Otus asio* (e.g., AOU 1957). One hundred years later, Marshall (1967) recognized four incipient species within this larger taxon: *O. asio, O. kennicottii, O. seductus,* and *O. cooperi*. This separation was formalized by AOU (1983) by resurrecting *O. kennicottii* and giving it the English name Western Screech-Owl. Indeed, AOU (1983, 1998) and König et al. (2000) now consider all four of Marshall's incipient species as allospecies of a superspecies.

Fifteen subspecies were recognized by Peters (1940) and 13 by AOU (1957). In the next major revision, Marshall (1967) considered much of the geographic variation in Western Screech-Owls to be clinal, and further reduced the number of subspecies to eight. Hekstra (1982a, 1982b), on the other hand, recognized 18 subspecies. In a recent revision based largely on morphometrics, Gehlbach (2003) retains eight subspecies, only slightly different from Marshall's treatment. Subspecies that range into British Columbia are:

- *O. kennicottii kennicottii*, along entire coast including the Gulf Islands and Vancouver Island.
- *O. kennicottii macfarlanei*, southern Interior, and west Kootenays.

Description

The Western Screech-Owl is a small owl (150–250 g) with noticeable feather tufts on the corners of its head. Generally cryptically coloured; breast and belly are pale with dark streaks, back is brownish (coast) or brownish-grey (interior) with fine dark streaks. *O. kennicottii kennicottii* is generally a large subspecies with brown base colour to its plumage, while *O. kennicottii* macfarlanei is greyer in colour and even larger in size.

Distribution

Global

Resident along the Pacific coast from southern Alaska south to Baja California, and in the interior areas of western North America from southern British Columbia south through western Montana, western Colorado, and western Texas south to central Mexico. The Interior Western Screech-Owl occurs east of the Cascade Mountains from southern British Columbia, south to Washington, Oregon, Idaho, and Montana.

British Columbia

The Interior Western Screech-Owl occurs in the Okanagan Valley. There are scattered records elsewhere in the southern Interior but no evidence of breeding. It probably breeds, at least irregularly, in the Thompson Valley between Chase and Spences Bridge. Breeding has recently been confirmed in the West Kootenays near Castlegar and Creston.

Forest region and districts

Southern Interior: Arrow Boundary, Cascades, Kamloops, Kootenay Lake, Okanagan Shuswap

Ecoprovince and ecosections

SIM: EKT, SCM, SFH, SHH, SPM

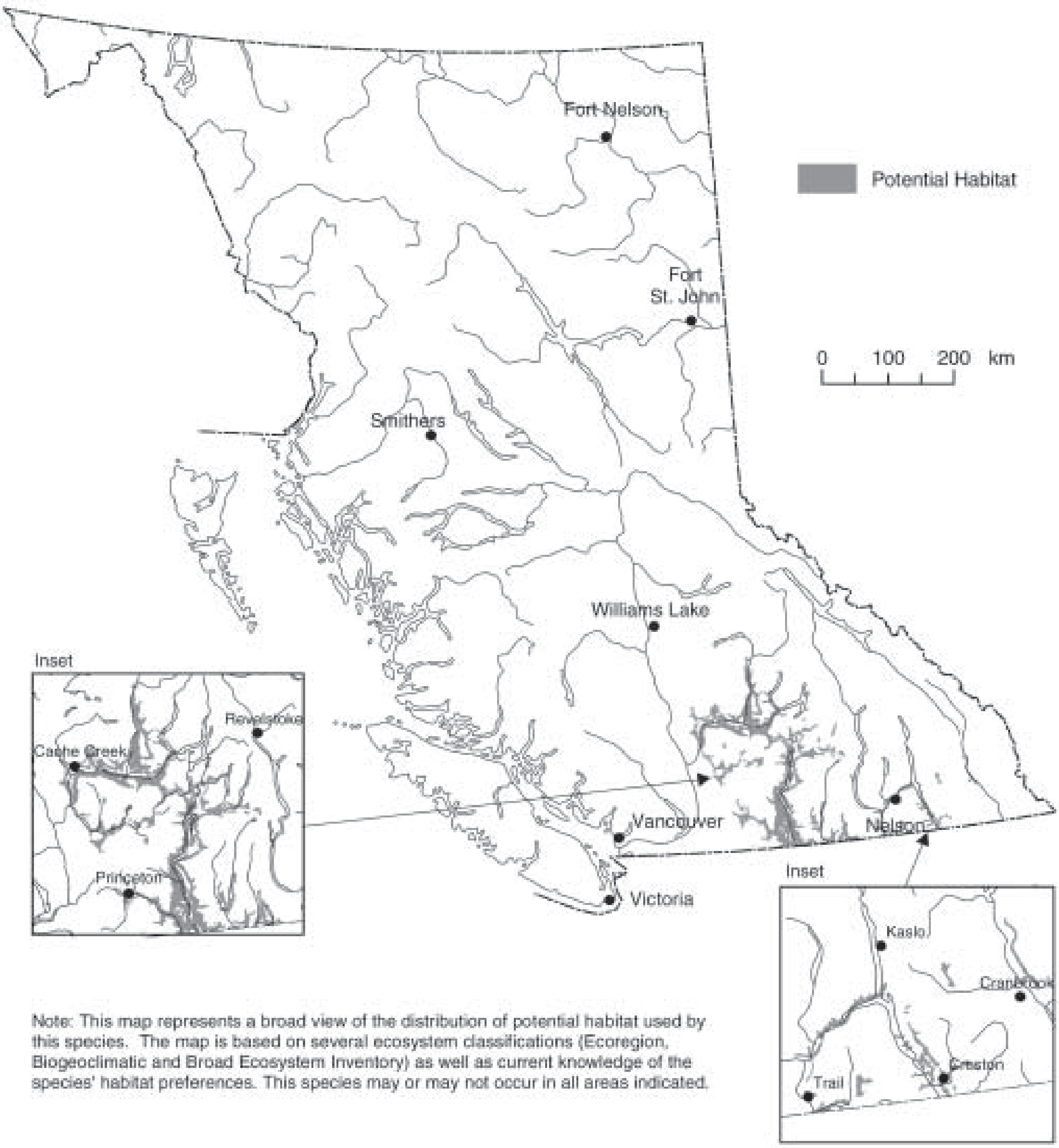
SOI: GUU, NIB, NOB, NOH, NTU, OKR, SHB, SOB, SOH, irregular in STU, THB, TRU

Biogeoclimatic units

BG: xh1, irregular in xh2, xw, xw1

PP: dh1, dh2, xh1, xh2

Western Screech-Owl - subspecies *macfarlanei*
(Otus kennicottii macfarlanei)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

IDF: dk1, dk2, dk3, dm1, mw1, mw2, xh1, xh1a, irregular in xh2, xw

ICH: dw, mw2, irregular in xw

Broad ecosystem units

CR, DF, DP, IG, PP, RR, SP, WL, WR

Elevation

0–700 m

Life History

Diet and foraging behaviour

The Western Screech-Owl is a generalist predator on small animals, including mice, shrews, birds, insects, frogs, salamanders, crayfish, fish, and earthworms (Cannings and Angell 2001).

Reproduction

Western Screech-Owls nest in tree cavities, including those excavated by Pileated Woodpeckers (*Dryocopus pileatus*) and Northern Flickers (*Colaptes auratus*); they also readily use nest-boxes. British Columbia nests ranged from 1.2 to 12.2 m above ground; all nests reported were in trees >25 cm dbh (n = 43; Campbell et al. 1990). There is a strict division of labour; males provide all the food for females and young while the females incubate the eggs and brood the young. Clutch size is two to seven eggs, usually three to five (Cannings and Angell 2001). Egg dates in British Columbia range from 17 March to 31 May (n = 49), most (53%)
9–21 April; dates for young in nests range from 19 April to 21 August (n = 53), with 51% from 8 May to 3 June (Campbell et al. 1990).

Site fidelity

Pairs are resident throughout the year on nesting territories (Cannings and Angell 2001).

Home range

Home range sizes can be very small in optimal habitat, but a reasonable estimate for home range size in British Columbia would be about 2.5–10 ha (Cannings and Angell 2001).

Dispersal and movements

The Western Screech-Owl is non-migratory; young birds disperse in late summer and fall to establish new territories. Both male and female young disperse from the natal area, but on average females travel about three times as far as males (about 15 km vs. 5 km) in the first 3 months of dispersal (Ellsworth and Belthoff 1997).

Habitat

Structural stage

6: mature forest
7: old forest

Important habitats and habitat features

Nesting

Breeding territories are closely associated with riparian habitats, particularly those dominated by black cottonwood (*Populus trichocarpa*), trembling aspen (*Populus tremuloides*), and water birch (*Betula occidentalis*) (Cannings 1997). Since cavities are needed for both nesting and roosting, a breeding territory must contain at least two suitable cavities to be useful to a pair of screech-owls. Nest trees may be in decay class 2 through 6.

Nesting and roosting sites are in tree cavities, usually those made by Northern Flickers or Pileated Woodpeckers in large diameter deciduous trees (though coniferous trees are also used). Dense vegetation and thickets are also used for roosting. Because cavities of Pileated Woodpecker and Northern Flicker are most often used, it may be important to consider the nesting requirements of these species in ecosystems where the Interior Western Screech-Owl occurs (see Appendix 12).

In the Okanogan National Forest, Pileated Woodpecker nesting sites generally had a high live basal area and tree density, and also a large number of snags in all diameter classes (Madsen 1985). Similar conclusions about the importance of high densities of large trees and snags have been found in other similar western coniferous forests. The Northern Flicker is less selective in stand structural features, and generally nest trees were located either within or close to open forest areas. However, Northern Flickers use old Pileated Woodpecker cavities.

Pileated Woodpeckers in northwestern Montana selected mainly western larch and occasionally Douglas-fir as nest trees (McClelland and McClelland 1999). They used ponderosa pine where there were groves almost entirely composed of ponderosa pine and Douglas-fir. In riparian forests, nest trees were in large black cottonwood and all aspen nest trees were in monospecific groves of aspen (McClelland and McClelland 1999). In northern Montana and in the aspen parklands in Alberta, aspen often is the only tree species that reaches sufficient size for Pileated Woodpecker nesting (Bonar 1997; McClelland and McClelland 1999). In south-central British Columbia, Pileated Woodpeckers nested exclusively in trembling aspen (Harestad and Keisker 1989). In the Okanogan National Forest, Northern Flickers selected ponderosa pine and western larch in greater proportion than Douglas-fir or other species (Madsen 1985). Northern Flickers preferred trembling aspen to conifers near Riske Creek (Wiebe 2001). Diameter at breast height (dbh) of nest trees differed particularly between coniferous and deciduous trees for both species of cavity-nester (Table 1).

In the Okanogan National Forest, Pileated Woodpecker nest trees were exclusively in decay stages 4 and 5 (Madsen 1985). Nest trees in northwestern Montana often had broken tops and fire scars were present on ≥50% of western larch, ponderosa pine, and aspen nest trees (McClelland and McClelland 1999). In northern Oregon, 45% of Pileated Woodpecker nest trees had intact tops, whereas 49% had ≥10% of the top broken off (these were largely ponderosa pine) (Bull 1987). Alternately, 92% of the nest trees in Alberta (mainly aspen) were living but all had signs of heartwood decay and conks were present on 62% of nest trees (Bonar 1997).

Conservation and Management

Status

The Interior Western Screech-Owl is on the provincial *Red List* in British Columbia. It is considered *Endangered* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	OR	WA	Canada	Global
S1	S4	S3S4	S4?	S5	N1	G5T4

Table 1. Dbh (mean ± SD) (cm) of Pileated Woodpecker and Northern Flicker nest trees in several locations.

Forest	Location	*n*	Pileated Woodpecker	*n*	Northern Flicker	Citation
Coniferous	Blue Mountains Oregon	13	75.3 ± 11.7			Bull 1975
Coniferous	Okanogan National Forest	6	84.2 ± 17.5	16	70.4 ± 27.2	Madsen 1985
Coniferous	Northern Montana	89	73.4 ± 1.9			McClelland and McClelland 1999
Coniferous	South central British Columbia	20	40.5 ± 7.1	17	31.9 ± 9.9	Harestad and Keisker 1989
Deciduous trees	Riske Creek, British Columbia			159	33.87 ± 10.34	Wiebe 2001

Trends

Population trends

Population trends are unknown, but is likely slowly declining, as habitat is lost at lower elevations in the Okanagan Valley.

Habitat trends

About half the riparian habitat in the south Okanagan Valley has been lost to urban or agricultural development over the last 50 years (Cannings et al. 1999) and a similar loss has likely occurred in the north Okanagan. This loss is particularly severe in the main valley and less critical along small creeks.

Threats

Population threats

Coastal populations of Western Screech-Owls seem to have suffered significant declines in the last 10 years due to a newly established predator, the Barred Owl (*Strix varia*) (pers. obs.; J. Hobbs, pers. comm.). Barred Owls began nesting on the south coast in the early 1990s and anecdotal evidence points to a concomitant decline in Western Screech-Owl breeding populations since then, both in the Greater Vancouver and Victoria areas (pers. obs.; D. Fraser, pers. comm.). Barred Owls are potentially a threat in the Interior as well (M. Chutter, pers. comm.)

Habitat threats

Habitat loss is the primary threat to the Interior Western Screech-Owl which occurs in riparian woodlands at low elevations in the Okanagan Valley, where approximately half of the suitable habitat has been lost in the last 50 years and most of the remaining habitat is degraded to some extent (Cannings et al. 1999). Livestock grazing, and burning to clear shrubs has reduced or altered suitable habitats along the Nicola Valley (J. Hobbs, pers. comm.)

Legal Protection and Habitat Conservation

The Western Screech-Owl, its nests, and its eggs are protected from direct persecution by the provincial *Wildlife Act*.

Some habitat is protected in the following parks: Coldstream Regional Park, Inkaneep Provincial Park, Okanagan Mountain Provincial Park, South Okanagan Grasslands Provincial Park, White Lake Grasslands Provincial Park, Woodhaven Regional Park, Mission Creek, Duck Lake, and Lac du Bois parks.

Habitat conservation may be partially addressed by the old forest retention targets (old growth management areas), riparian reserves, and wildlife tree retention area recommendations in the results based code.

The results based code riparian guidelines likely afford little direct protection for Interior Western Screech-Owl habitat, since many territories are along very small non fish bearing streams and wetlands. Harvesting is permitted within the riparian management zones often resulting in loss of large diameter trees and snags for nesting and roosting. It is also likely that upland forest habitat is also important for foraging.

Special riparian management zones outlined in the Okanagan Shuswap Land and Resource Management Plan are similar to those of the results based code.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Because this species depends largely on woodpecker cavities, particularly those of Northern Flickers and Pileated Woodpeckers, for nest sites, management practices that benefit woodpeckers will also enhance habitat for the Western Screech-Owl.

❖ The objective for this species is to maintain wildlife trees and green recruitment trees for nesting across the breeding range and over time. Consider wildlife tree retention (WTR) areas, RMAs, and OGMA objectives for this species in the following forest districts: Okanagan Shuswap, Kamloops, Cascades, and Arrow Boundary.

- ❖ Blocks should be assessed to identify potentially suitable WTR areas. Suitable WTR areas for this species should be based on the information in Table 2.
- ❖ It is recommended that salvage not occur in WTR areas and OGMAs established to provide habitat for this species. In addition, these areas should be designed to include as many suitable wildlife trees as possible and that they should be maintained over the long term (>80 years).
- ❖ Maintain forested riparian management zones.

Wildlife habitat area

Goal

Because few nest areas are known for this subspecies, these sites should be established as WHAs. Suitable habitat should be managed through the wildlife tree retention within landscape level planning objectives.

Feature

Establish WHAs at known nest sites or occupied residences. Residency is indicated by detections during the breeding season.

Size

Typically between 5 and 30 ha. Size should be based on estimated home range size using habitat suitability and number of occupied breeding territories. Areas of highly suitable habitat may have more than one occupied breeding territory.

Design

Design the WHA to minimize disturbance and maintain suitable foraging habitat. The WHA should include a 5–12 ha core area for the nest area and may include a ~100 m management zone (i.e., smaller WHAs may be managed as a no harvest core area only). The management zone should include suitable foraging habitat. Other features to include are large diameter snags (particularly black cottonwood, trembling aspen, water birch, and broadleaf maple) with suitable nest cavities.

General wildlife measures

Goals

1. Maintain nesting and foraging habitat.
2. Maintain an adequate supply of suitable wildlife trees and associated nest and roost cavities.
3. Maintain a healthy riparian habitat.
4. Minimize disturbance to roost and nest sites.
5. Maintain native vegetation.
6. Maintain/encourage deciduous component in riparian and conifer stands.
7. Ensure WHA is windfirm.
8. Maintain riparian areas in properly functioning condition.

Measures

Access

- Do not construct roads or stream crossings in the core area. Within the management zone, avoid constructing roads or stream crossings.

Table 2. Preferred WTP characteristics for the Interior Western Screech-Owl

Attribute	Characteristics
Size (ha)	≥2.5 ha
Location	PPxh, PPdh, IDFxh, IDFxw, IDFdk, IDFmw; riparian areas
Tree features	visible woodpecker or natural cavities
Tree species	deciduous preferred; trembling aspen, black cottonwood, water birch, Douglas-fir, possibly ponderosa pine, and western larch
Tree size (dbh)	deciduous spp.: 34–44 cm or larger; coniferous spp. 74–85 cm or larger; in the absence of trees with the preferred dbh, trees with ≥30 cm dbh should be retained for recruitment
Wildlife tree class	2–6

Harvesting and silviculture

- Do not harvest or salvage within the core area.
- In PP and IDF zones, selective harvest of ≤20% basal area may occur within the management zone provided no suitable wildlife trees (see Table 2) are removed.
- Do not harvest or salvage within the management zone during the breeding season (1 March to 15 August).
- Retain deciduous species.
- Within riparian management zones, retain >60% of trees including all suitable wildlife trees (see Table 2).

Pesticides

- Do not use pesticides.

Range (BG, PP, and IDF zones)

- Plan livestock grazing (timing, distribution, and level of use) to maintain desired structure of plant community, desired stubble height, and browse utilization.
- Do not place livestock attractants within WHA.
- Do not burn understorey vegetation.

Recreation

- Do not construct trails within 50 m of a known nest site.

Additional Management Considerations

Consider fencing stream or stock-watering works to limit the access of livestock to a stream within the WHAs.

Consider using nest-boxes if wildlife trees and other trees with suitable cavities have been felled for safety reasons.

Information Needs

1. Habitat use and home range size. It would be very useful to find out the degree to which owls use coniferous forests adjacent the riparian zone during foraging bouts.
2. Impact of Barred Owl predation and any opportunity to design WHAs to reduce/minimize predation by Barred Owls.

Cross References

Lewis's Woodpecker, Yellow-breasted Chat

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Prairie Falcon

Falco mexicanus

Original[1] prepared by John M. Cooper

Species Information

Taxonomy

The Prairie Falcon is placed in the family Falconidae, along with caracaras, forest falcons, and other true falcons (Sibley 2001). In British Columbia, this family is represented by five species of true falcons (genus *Falco*): American Kestrel (*F. sparverius*), Merlin (*F. columbarius*), Peregrine Falcon (*F. peregrinus*), Gyrfalcon (*F. rusticolus*), and Prairie Falcon (*F. mexicanus*) (Campbell et al. 1990). There are no recognized subspecies of Prairie Falcon (AOU 1957; Cannings 1998).

Description

The Prairie Falcon has cryptic plumage which makes it less conspicuous in the grassland and cliff habitats it inhabits. Its back and dorsal wing surfaces are pale brown, while its ventral surface is mostly cream coloured with dark streaks on the chest and underwings. In contrast, the axillary feathers form a very dark triangle on each underwing that are distinctive to this species and are easily seen from below when the bird is in flight. Its facial pattern includes a narrow moustachial and ear covert stripe. Like other true falcons, Prairie Falcons have long, narrow, pointed wings. Prairie Falcons are 40–50 cm in length with a wingspan of about 100 cm. In general, they are slightly smaller and lighter in colour, and have fewer distinct facial markings than the closely related Peregrine Falcon.

Distribution

Global

Prairie Falcons breed from central British Columbia, southern Alberta and Saskatchewan, south to Baja California, Arizona, New Mexico, Texas, and Northern Mexico. They winter throughout their breeding range as well as east to the Mississippi and south to Central Mexico (AOU 1957; Howell and Webb 1995; Steenhof 1998).

British Columbia

Prairie Falcons breed locally in the Southern Interior ecoprovince, and along the Fraser and Chilcotin rivers of the southern Central Interior ecoprovince (Campbell et al. 1990). Small numbers may also breed in the Boundary region and in the East Kootenay Trench (Cooper 1998; Fraser et al. 1999).

After the breeding season the population is more widely scattered, although the majority of birds probably shift south, with many birds leaving the province (Campbell et al. 1990).

Forest region and districts

Southern Interior: 100 Mile House,* Arrow Boundary, Cascades,*[2] Central Cariboo,* Chilcotin,* Kamloops,* Kootenay Lake, Okanagan Shuswap,* Rocky Mountain

Ecoprovinces and ecosections

CEI: CAP, CAB, CHP, FRB

SIM: EKT[3] (SCM, MCR wintering only)

SOI: GUU, NIB, NOB, OKR, SHB, SOB, SOH, STU, THB, TRU

Biogeoclimatic units

AT

BG: xh1, xh2, xh3, xw, xw1, xw2

ICH: (dw, mw2, xw – wintering only)

IDF: dk1, dk2, dk3, dk4, dm1, mw1, mw2, xh1a, xh2a, xm, xw

MS: xk

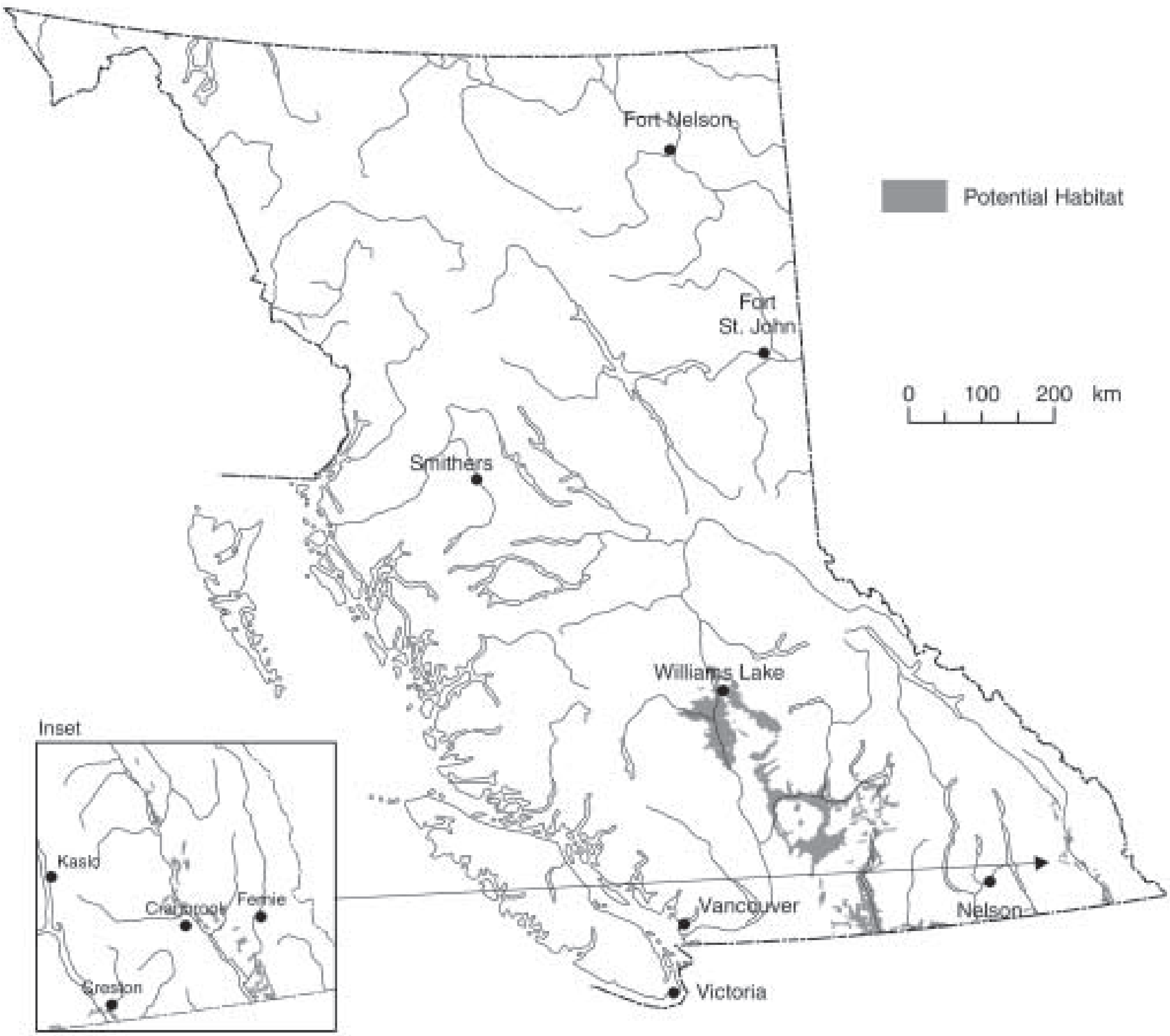
1 Volume 1 account prepared by M. Sarell.

2 * Indicates breeding.

3 Possible breeding.

Prairie Falcon

(Falco mexicanus)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

PP: dh1, dh2, xh1, xh2
SBPS: xc

Broad ecosystem units

Breeding: AB, BS, ME, RO, SS (DF, DP, PP – steep south facing slopes only)

Non-breeding: AB, BS, CF, CR, ME, SS, (DF, DP, PP – in seral stage 1 only)

Elevation

In British Columbia, nesting has been documented from 450 to 900 m elevation (Campbell et al. 1990). There are unconfirmed reports of nesting close to 2000 m elevation. In the non-breeding season, this species has been recorded from sea level to 2440 m (Campbell et al. 1990).

Life History

Diet and foraging behaviour

Prairie Falcons primarily prey on small- to medium-sized birds, including the Mourning Dove (*Zenaida macroura*), Horned Lark (*Eremophila alpestris*), Western Meadowlark (*Sturnella neglecta*), and Vesper Sparrow (*Pooecetes gramineus*), and small mammals such as yellow-pine chipmunks (*Tamias amoenus*), ground squirrels, and the Yellow-bellied Marmot (*Marmota flaviventris*) (Cannings et al. 1987; Hunt 1993; Hooper and Cooper 1997). They also take small reptiles and insects, especially grasshoppers, although these likely constitute a smaller percentage of their diet.

Prey is typically caught on the ground with the falcon using its considerable speed to surprise and subdue its prey (Beebe 1974).

Reproduction

In the spring, Prairie Falcons return to their breeding grounds and pairs are typically reunited although, in areas with high densities, mate switching has been documented (Beebe 1974). Following a courting period involving aerial displays by the male, nesting may begin as early as late March, however late April is more common in British Columbia (Beebe 1974; Campbell et al. 1990). Records for 3 clutches from British Columbia had 3– 4 eggs (Campbell et al. 1990). Elsewhere, clutches of 3–6 eggs have been recorded, with 4–5 being most common (Baicich and Harrison 1997). The female does almost all of the incubating while the male feeds her, although the male may occasionally relieve her while she hunts (Beebe 1974; Call 1978). Incubation begins with the first egg laid and lasts from 29 to 33 days (Campbell et al. 1990; Baicich and Harrison 1997). Nestlings leave the nest after about 40 days. Young are fed by adults and may remain in the vicinity of the nest site for a variable amount of time after fledging (Beebe 1974; Cannings et al. 1987).

Prairie Falcons typically begin breeding at 2 years of age, although there are records of breeding in 1-year-old birds. One brood is raised annually.

Site fidelity

Prairie Falcons demonstrate a high degree of site fidelity at breeding areas and are often known to reuse the same site for several successive seasons and possibly for several generations (Lehman et al. 2000). Though nest sites are often reused, falcons may also use alternate nest sites within their breeding territory over successive seasons (Call 1978; Steenhof 1998). In one study of a prairie falcon population in Idaho the adult males sometimes moved to alternate aeries that averaged 1.5 km from previously used aeries (Lehman et al. 2000).

Prairie Falcons are solitary breeders although they may occur in higher densities in areas with abundant food supplies and nest sites. The densest known breeding concentrations are along the Snake River in southwestern Idaho, where up to 206 breeding pairs have been found along 130 km of river valley (Steenhof et al. 1999). In the Chilcotin-Cariboo region of British Columbia, there were an estimated one pair per 6 linear kilometres of cliff face (Hooper and Cooper 1997), but this estimate was based on very scant data.

Home range

No data are available for home range size in British Columbia. Elsewhere, birds have been recorded travelling up to 26 km from their nest site in search of food.

Migration is not well defined. Some birds remain in breeding areas year round; however, Prairie Falcons appear to leave areas with low food supply in the winter (although dispersal is not necessarily to the south) (Campbell et al. 1990). Young birds may also wander more extensively than mature adults (Beebe 1974).

There may be seasonal altitudinal movement, with falcons moving to higher altitudes in the late summer, post-fledging, where prey may be more accessible relative to their breeding areas (Beebe 1974). There are relatively numerous records in British Columbia of Prairie Falcons in alpine areas during August and September relative to other seasons (Cooper 1989; Campbell et al. 1990)

Habitat

Structural stage

1: non-vegetated
2: herb
3: shrub/herb

Important habitats and habitat features

Foraging

During the breeding season, Prairie Falcons usually hunt over grasslands and sagebrush steppe habitat near the aerie. Prairie Falcons require ample, accessible prey near the nest site. Because prey is usually taken on the ground, open areas (i.e., grassland habitat) are important to their forage success. Open areas with relatively low density, patchy vegetation provide suitable forage for small mammals and birds and opportunities for the falcons to access their prey.

Nesting

Extensive open areas such as grasslands and sagebrush steppe habitat, with an abundant prey base and suitable cliffs for nesting are important breeding habitats (Cannings et al. 1987; Campbell et al. 1990).

Aeries are located in cliff faces, usually on a shelf, within a small cave or in a pothole in the cliff face (Baicich and Harrison 1997). An overhang over the nest is required, presumably to protect the nest from sun (Beebe 1974). Nest height from the base of the cliff in British Columbia ranges from 15 to 138 m (Campbell et al. 1990). Nests are almost always on rocky substrates, rarely on earthen banks, and consist of a shallow scrape (Call 1978; Baicich and Harrison 1997; Hooper and Cooper 1997). This species is also known to reuse abandoned cliff nests built with sticks by other raptors, but does not build stick nests itself (Baicich and Harrison 1997). Nests are usually near (0–6 km) open country.

Migration

Habitat requirements are probably similar to breeding season, although smaller open habitats, and habitats away from cliffs are used. Within British Columbia, alpine areas also appear to be used during the fall migration (Campbell et al. 1990).

Wintering

Open country with a sufficient prey base is required for populations wintering in British Columbia. Wintering birds occur regularly in small numbers near Kamloops and in the Okanagan Valley (Campbell et al. 1990).

Conservation and Management

Status

The Prairie Falcon is on the provincial *Red List* in British Columbia. In Canada, it is considered to be *Not At Risk* (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	BC	ID	MT	OR	WA	Canada	Global
S3B, S2N	S2B, SZN	S5B, S3N	S4	S4	S3B, S3N	N3B, N3N	G5

Trends

Population trends

Historic population sizes are not well known, but it is generally believed that numbers in British Columbia are near all-time lows (Cooper 1998; Fraser et al. 1999). Many of the known, historic aeries are no longer occupied. Population size issues are further complicated by migration patterns that result in overlapping populations of wintering, migrating, and resident birds.

In British Columbia the Prairie Falcon population may have reached a peak in the 1920s when this species began to expand and occupy former Peregrine Falcon aeries. Peregrine Falcons were in decline at that time in southern British Columbia (Campbell et al. 1990). A similar situation occurred to some extent throughout the Prairie Falcon's entire North American range (Beebe 1974). By the 1940s, the Prairie Falcon population in the Okanagan was declining (Cannings et al. 1987) and, although data are limited, it seems likely that the same was happening across the province (Campbell et al. 1990). By the 1980s, the Okanagan Valley population appeared to be increasing (Cannings et al. 1987), perhaps in response to better wildlife management practices and positive effects from the ban on DDT use. However, the population in British Columbia may now have stabilized at an historic low (Cooper 1998; Hobbs 2001). In the rest of Canada, populations are currently thought to be increasing or stable (Kirk and Banasch 1996)

In general, population trends are difficult to determine because densities are too low for breeding bird survey results to yield significant data. In the United States, Christmas bird count data indicate that wintering populations there are stable (Platt and Enderson 1989). Nest area surveys are considered the only effective monitoring technique, but are expensive and labour intensive (see Hobbs 2000, 2001), and therefore have not been done on a large scale across the range (Fuller 1997; Hooper and Cooper 1997). One well-studied breeding population in the Snake River of southwestern Idaho, however, is known to have declined significantly from 1976 to 1997 (Steenhof et al. 1999).

Habitat trends

Foraging habitat near many traditional aeries has been altered (Fraser et al. 1999). Conversion of grassland and sagebrush foraging habitat to agricultural lands has reduced habitat availability in many areas (Cooper 1998). In the south Okanagan, developments have altered >60% of the grassland and shrub habitats, and only 9% remains in a relatively undisturbed state (MELP, no date). Since then, in the past 3 years, the amount of steppe habitat adjacent to the last regularly used aerie in the south Okanagan has been reduced significantly by a new vineyard. In addition, the amount of suitable breeding habitat available in British Columbia has been reduced and degraded by human activities (Fraser et al. 1999). Urban or industrial sprawl has encroached to the base of some former nesting cliffs (Cooper 1998).

Threats

Population threats

The Prairie Falcon population in British Columbia was probably impacted by the use of DDT in the province, with the decline in breeding pairs coinciding with the introduction of this pesticide (Cannings et al. 1987; Risebrough and Monk 1987). Although DDT is no longer being used in British Columbia, or elsewhere in Canada and the United States, there are residual organochlorines in the ecosystem, and falcons may also be exposed to pesticides on their wintering grounds if they leave the region (Risebrough and Monk 1987; Banasch et al. 1993). Furthermore, some prey species are migratory birds, and likewise may become contaminated with pesticides on their wintering ground (Banasch et al. 1993; Fraser et al. 1999). Renewed use of organochlorines or other biocides poses the greatest potential future threat for this species (Platt and Enderson 1989).

Other threats to the population include reduction of nesting productivity due to loss of productive hunting grounds through conversion to agriculture or urban sprawl (Cooper 1998). Availability of prey has been well documented as a critical factor for productivity of raptors (Garton et al. 1989). Prey availability in British Columbia may have been reduced through persecution of ground squirrels, an important food item during the breeding season (MELP, no date). In Idaho, annual breeding productivity was closely linked with ground squirrel abundance, but no long-term trends correlated with ground squirrel abundance (Steenhof et al. 1999). Weather, in the form of droughts, affected ground squirrel abundance, and was therefore the causal mechanism for lower annual productivity (Steenhof et al. 1999). In Alberta, increasing amounts of land used for agriculture along the Bow River, and the correlated loss of ground squirrel populations were thought to be the likely cause of a declining occupancy rate of Prairie Falcon aeries (Hunt and Holroyd, pers. comm. in Kirk and Banasch 1996).

Human disturbance at aeries can lead to abandonment of nests and the long-term avoidance of traditional nesting cliffs (Campbell et al. 1990). Disturbance could be caused by recreational activities (e.g., rock climbing) or other land use practices (e.g., timber harvest near nest sites; Hobbs 2001). Disturbance due to intensive military training exercises in foraging areas in Idaho has proven to reduce foraging success by Prairie Falcons and is correlated with lower productivity (Steenhof 1998).

Harvest by falconers may be an ongoing threat, but is tightly regulated by government, and some studies have shown that controlled harvests do not affect populations (Platt and Enderson 1989). Shooting is unlikely to pose a current threat to populations, although in the past, extermination programs throughout the Prairie Falcon's range undoubtedly had an impact on historic populations (Cannings et al. 1987).

Habitat threats

Currently in British Columbia, the primary threat to this species is loss of foraging habitat near aeries, primarily through conversion of grassland and sagebrush steppe to agricultural land (Campbell et al. 1990; Hooper and Cooper 1997; Fraser et al. 1999). Fire suppression and subsequent forest encroachment into grassland also reduce suitable foraging areas (Cooper 1998; Hobbs 2001). For example, grassland habitats in the Chilcotin-Cariboo region of British Columbia have been reduced by 30% in the last 30 years (Hooper and Pitt 1995). Invasion by exotic plants into native grasslands may negatively impact prey abundance and availability for Prairie Falcons (Steenhof et al. 1999).

Elsewhere, lack of availability of suitable nest sites near adequate prey supply are cited as the limiting factors for Prairie Falcon populations (Millsap et al. 1987).

Legal Protection and Habitat Conservation

The Prairie Falcon, its nests, and its eggs are protected from direct persecution in British Columbia under the provincial *Wildlife Act*.

In the Chilcotin-Cariboo region, three nest sites are within an existing wildlife habitat area (WHA) and another is in a provincial park (Hobbs 2001). Two historic Prairie Falcon aeries in the southern grasslands are in provincial parks, and one is protected within an ecological reserve (Hobbs 2000). One of these sites was active in 1995 but not in 2000 (Hobbs 2000), while the other has been taken over by Peregrine Falcons (Cooper 1998; Hobbs 2000).

Conservation of habitat on Crown land may be partially addressed by FRPA's range use guidelines. These include setting objectives for (1) "desired plant community" to promote Prairie Falcon prey species, (2) suitable livestock grazing levels in areas important for Prairie Falcons, (3) special conditions and practices to enhance habitat values for Prairie Falcons, and (4) provisions for limiting spread of invasive species.

Identified Wildlife Provisions

Wildlife habitat areas

Goal

Maintain suitable breeding habitat.

Feature

Establish WHAs at aeries active within the last 5 years.

Size

Approximately 300 ha but may vary depending on site-specific factors.

Design

Design will depend on natural features such as watercourses and contours, and other factors such as land tenure. In general, the shape of the WHA will reflect the best ecological protection possible of breeding and foraging habitats. The core area should be 300 m radius (~28 ha) around aerie (nest site). The management zone area will include the remaining area.

General wildlife measures

Goals

1. Minimize disturbance at breeding sites.
2. Maintain structural components of rangeland to enhance/maintain prey species and foraging opportunities for Prairie Falcons.
3. Maintain structural components of the forest edge including wildlife tree retention.
4. Minimize soil disturbance and invasion of invasive species.
5. Maintain suitable foraging habitat.
6. Prevent or control forest encroachment.

Measures

Access

- Do not construct roads within the core area.
- Do not construct roads or blast within the management zone area during the breeding season (15 March–30 July).

Harvesting and silviculture

- Do not harvest or salvage within the core area except for treatments to control forest encroachment.
- Do not harvest or salvage during the breeding season (15 March–30 July).
- Maintain a selection of mature trees (age class 6–9) and large snags largest within the stand, preferably of decay class 2–4.
- Maintain shrub patches.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing (distribution, timing, intensity) to meet objectives described above (GWM goals).
- Delay burning or mowing of meadows near aeries (within 1 km radius of aerie) until after the breeding season (15 March–30 July).

Recreation

- Do not develop recreational trails, facilities, or structures within the core area.

Additional Management Considerations

MWLAP may need to build a co-operative relationship with landowners who own cliffs with aeries, or important grassland foraging habitat, to effectively conserve some individual breeding sites.

Areas near active aeries should be managed to minimize urbanization and negative impacts of disturbance by humans, vehicular traffic, and domestic animals, especially during the breeding season (15 March–30 July).

Incompatible human activities should be regulated within the WHA. These include plowing or tilling land, off-road vehicle use, camping, firewood cutting, and pesticide applications.

Information Needs

1. Status of historical breeding localities and inventory for new sites in areas that have not been surveyed recently, especially in the grasslands of the Thompson, lower Fraser, and Okanagan valleys; and the East Kootenays.
2. Impacts of urbanization and human recreational use of nesting areas on reproductive success.
3. Productivity of known breeding pairs.

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Short-eared Owl

Asio flammeus flammeus

Original prepared by John M. Cooper
and Suzanne M. Beauchesne

Species Information

Taxonomy

One subspecies, *Asio flammeus flammeus*, is recognized over most of this species' range including British Columbia (AOU 1957; Cannings 1998). Eight or nine other subspecies occur in disjunct populations in South America and on islands elsewhere in the world (Holt and Leasure 1993).

Description

The Short-eared Owl is a medium-sized owl with small ear tufts. At a distance it appears to be a pale buff colour, with black "wrist" patches on the wing. Its flight is moth-like, with erratic wing beats, typically carrying it low over the ground. When perched, it sits slantwise, rather than vertical, as do most other owls of its size.

Distribution

Global

Short-eared Owls breed across subarctic and temperate North America and Eurasia as well as on the grasslands of South America and some islands including Hawaii, the Galapagos, the Falkland Islands, Cuba, Puerto Rico, Borneo, and the Philippines. Some populations are resident; however, the northernmost populations are migratory. In North America, birds winter from extreme southern Canada, south to central Mexico. Eurasian birds winter in the Mediterranean region of Europe, Northern Africa, and southern Asia to Malaysia (Holt and Leasure 1993).

British Columbia

Short-eared Owls breed locally on the south mainland coast, through the Fraser River delta east to Fort Langley, in the south and central Interior north through the Thompson and Chilcotin-Cariboo basins to Prince George, and in the Peace Lowland. It is an uncommon migrant throughout the province. The Fraser River delta is the main wintering area in the province although a few birds winter on southeastern Vancouver Island and in the southern Interior (Campbell et al. 1990).

Forest regions and districts

Coast: Campbell River, Chilliwack, North Island, South Island

Northern Interior: Fort Nelson, Peace (Mackenzie probable), Prince George, Skeena Stikine

Southern Interior: 100 Mile House, Arrow Boundary, Central Cariboo, Chilcotin, Columbia (possible), Kamloops, Kootenay Lake, Okanagan Shuswap, Quesnel, Rocky Mountain

Ecoprovinces and ecosections

BOP: KIP, PEL

CEI: CAB, CCR, CHP, FRB, QUL

COM: NIM, WIM

GED: FRL, GEL, LIM, NAL

NBM: TAB

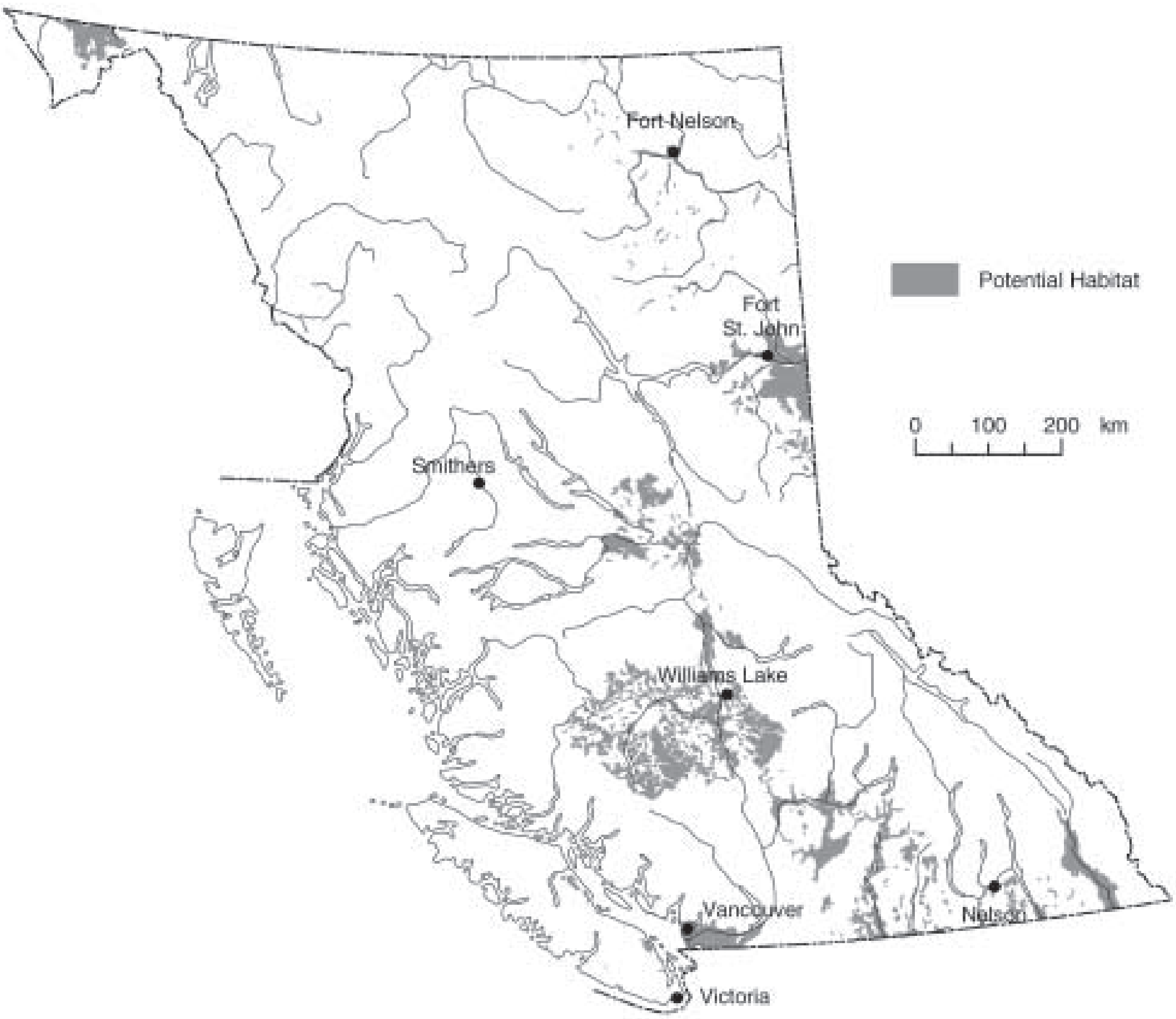
SBI: NEL

SIM: EKT, SCM, SFH, SPM

SOI: GUU, NIB, NOB, NOH, OKR, SHB, SOB, SOH, STU, THB, TRU

TAP: FNL, MUF, MUP

Short-eared Owl
(Asio flammeus)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Biogeoclimatic units

BG: xh1, xh2, xh3, xw, xw1, xw2

BWBS: dk1, mw1

CDF: mm

CWH: dm, vm1, xm1, xm2

ICH: mw2, xw

IDF: dk1, dk1a, dk3, dk4, dm, mw1, mw2, un, xh1, xh1a, xh2, xh2a, xm, xw

PP: dh1, dh2, xh1, xh1a, xh2

SBS: mh, mk1

SWB: dk

Broad ecosystem units

AB, BS, CF, DF, DP, ES, GO, ME, MS, OV, PP, RR, SM, SS, UR, WG, WL, WP, WR, YB

Elevation

Near sea level to 975 m, occurrence up to 2165 m (Campbell et al. 1990)

Life History

Diet and foraging behaviour

Short-eared Owls are prey specialists, concentrating on small rodents (primarily microtines), which undergo regular population cycles (Wiebe 1991; Sullivan 1992; Holt and Leasure 1993). When microtine populations crash in one area, Short-eared Owl populations must move to find a new prey supply. Other small mammals, insects, and birds are taken in lesser quantities.

Short-eared Owls usually hunt in a low flight path over grasslands, marshes, fallow fields, and other open areas. They also hover or hunt from a perch (Wiebe 1987; Holt and Leasure 1993).

Reproduction

Monogamous pair bonds are formed in the late winter and likely last only for a single season (Holt and Leasure 1993). Nesting may begin as early as late March, although late April to early May is more common in British Columbia (Campbell et al. 1990). In British Columbia, clutch size ranges up to 13 eggs, but six or seven eggs are most common (Campbell et al. 1990). Clutch sizes are larger in times of greater prey abundance (Johnsgard 1988). The female alone incubates the eggs for 24–28 days. Incubation begins before the clutch is completed, resulting in asynchronous hatching of young. The male brings food to the incubating and brooding female. Nestlings leave the nest after about 12–16 days but are unable to fly for another 10–12 days (Holt and Leasure 1993).

Short-eared Owls begin breeding at one year of age. One brood is probably raised annually. Some researchers believe that a second brood may be raised during years of extremely abundant prey, although conclusive evidence is lacking. Restarts after nest failure have been documented (Johnsgard 1988; Holt and Leasure 1993).

Nests are placed in open areas such as fallow fields, dry marshes, or grasslands with sufficient ground cover to conceal nests. This species is unusual among owls in that it builds its own nest, rather than using the nest of another bird species (Johnsgard 1988). Nests are built on the ground, in a scrape lined with vegetation and feathers (Campbell et al. 1990; Holt 1992; Semenchuk 1992; Holt and Leasure 1993). Nests are usually on dry, raised ground, although wet areas may also be used (Holt and Leasure 1993).

Site fidelity

Nest sites are infrequently reused in subsequent years; however, it is uncertain whether this is by the same or different individuals (Bent 1938). In general, nest site fidelity is not strong, presumably because this species is nomadic. Roosts may be used year after year.

Home range

Although Short-eared Owls are territorial during the breeding season, they have been documented nesting close to one another in good habitat where prey is abundant (Johnsgard 1988). Densities of breeding pairs have been as high as 1 pair/5.5 ha (Holt and Leasure 1993). In Manitoba, mean size of five territories was 73.9 ha (Clark 1975). Territory size may decrease with increasing prey densities (Clark 1975).

In winter, this species is non-territorial, congregating where there is suitable habitat and a good prey supply. In British Columbia, roosts with up to 110 birds have been documented in the Fraser River delta (Campbell et al. 1990).

Dispersal and migration

In British Columbia, the Short-eared Owl is primarily a migratory species, with most individuals breeding in the Interior then moving southward in the fall. Populations in the northern breeding range of British Columbia begin fall migration in late October (Campbell et al. 1990). Some individuals, particularly in the Fraser River delta, are resident (Campbell et al. 1990; Sullivan 1992). It is possible that this species only migrates in search of food, and that more owls do not migrate in years when prey is abundant (Cadman 1994).

Habitat

Structural stage

Breeding

2–3 or old-growth field

Wintering

2–3a and old-growth field (multi-year crop rotation)

Important habitats and habitat features

Foraging

The Short-eared Owl requires ample, accessible prey near the nest site. Open areas with patchy vegetation provide suitable forage for small mammal prey species and opportunities for the owls to access their prey.

Nesting

Extensive open areas such as grasslands, savannahs, rangeland, or marshes with an abundant prey base, suitable nest sites, and adequate roosting sites are important breeding habitats (Cannings et al. 1987; Campbell et al. 1990). In British Columbia, most of the nests reported in Campbell et al. (1990) were found in shrubby, grassy fields adjacent to agricultural areas (e.g., pastures, fallow fields, and cultivated fields). Other sites, in order of frequency, included airport fields, marshes, open rangeland, sagebrush plains, and hayfields. In the Peace Lowlands (B.C.), uncultivated edges around wetlands are also used (M. Phinney, pers. comm.). Elsewhere, Short-eared Owls have been documented using newly cleared forests (Johnsgard 1988; Semenchuk 1992; Holt and Leasure 1993). Nests are usually situated on a raised, dry site within low, concealing vegetation (Holt and Leasure 1993).

Wintering

It is likely that the availability of suitable winter habitat with a sufficient prey base and adequate roost sites is the limiting factor for wintering populations in British Columbia (Butler and Campbell 1987; Campbell et al. 1990). Open areas such as marine foreshores, estuaries, marshes, grasslands, fallow fields, hay fields, pastures, airports, and golf courses are used by this owl (Cannings et al. 1987; Johnsgard 1988, Semenchuk 1992; Holt and Leasure 1993). In the Fraser River delta, Short-eared Owls have been reported to favour “old-field” habitat characterized by variable grass heights and shrub patches (Campbell et al. 1990; Searing and Cooper 1992; Sullivan 1992).

Prey abundance and accessibility are critical factors for wintering Short-eared Owls, both of which seem to be strongly linked with old-field habitat. In the Fraser River Valley, Townsend’s Vole (*Microtus townsendii*) is the most abundant microtine and their highest densities are in old-field habitat. Small mammals also tend to be more accessible to owls in old-field habitat rather than in the uniform vegetation of cultivated fields (Cadman 1994).

Roosting

Winter roost sites must be close to hunting areas, provide protection from the weather and concealment from predators and mobbing birds, and be relatively free from human disturbance. This owl typically roosts on the ground within tall grass or shrubs, or in hedgerows (Holt and Leasure 1993). On Sea Island (British Columbia), roosts often occur in patches of Scotch broom (*Cytisus scoparius*). They will also roost in trees when snow depths exceed 5 cm (Johnsgard 1988).

Migration

Habitat requirements are probably similar to breeding season, although smaller open habitats may be used (Holt and Leasure 1993).

Conservation and Management

Status

The Short-eared Owl is on the provincial *Blue List* in British Columbia. It is considered a species of *Special Concern* in Canada (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

Population size and trends are difficult to assess because this owl is cyclic and nomadic, an unknown portion of the population nests in remote, unsurveyed regions, and even within easily accessible, known owl habitat, there has been a lack of consistent standardized census effort (Holt and Leasure 1993, Cadman 1994). Although these owls are occasionally active during the day, they are easily overlooked when roosting because they roost in heavy cover on the ground, and are usually well camouflaged. Estimating population size is further complicated by migration patterns because wintering, migrating and resident bird populations overlap (Cannings et al. 1987). During the breeding season, females are reluctant to flush off nests, making nests difficult to locate and breeding status difficult to determine (Holt and Leasure 1993).

At this time there is insufficient data to assess the overall population trend in British Columbia. However, Munro and Cowan (1947) suggested an apparent province-wide decline over the previous 15–20 years. In the Fraser River delta, evidence suggests that the local population has been in decline for the last few decades (Campbell et al. 1990). In addition, Christmas Bird Count data from the Lower Mainland show a steady reduction in peak number of Short-eared Owls from 1984 to 1990 (Campbell et al. 1990). In the 1960s, several hundred Short-eared Owls were banded on Sea Island (Campbell et al. 1990), but it is unlikely that the reduced amount of habitat on Sea Island today could support such numbers now.

Habitat trends

This species relies on winter habitat that has been significantly reduced and is further threatened (Tate 1986; Fraser et al. 1999). Habitat at lower elevations is undoubtedly less abundant than in the past. In the Southern Interior Mountains Ecoprovince, most low elevation grassland has been converted to agricultural lands and marshes have been drained. In the Central Interior Ecoprovince, and likely elsewhere (e.g., East Kootenay Trench ecosection), potential breeding and foraging habitat is being lost as grasslands are reduced by forest encroachment due to fire suppression (Hooper and Pitt 1995).

On the coast, estuarine marshes have been eliminated by industrial development and fallow fields have been converted to housing, industry or more intensive agricultural practices.

Threats

Population threats

As a ground nesting species, hazards to nests and nestlings include fire, flooding of marsh or coastal

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AK	CA	ID	MT	OR	WA	Canada	Global
S3B, S2N	S3N, S5B	S3	S5	S4	S4?	S4B, S4N	N4N, N5B	G5

habitat, farm machinery, and predators (Campbell et al. 1990; Cadman 1994). Mortality in adults has also been attributed to shooting; collisions with cars, aircraft, and other machinery; and entanglement with barbed wire and hip chain (Holt and Leasure 1993; Cadman 1994).

Elsewhere in North America, Short-eared Owls have been extirpated from areas that still contain apparently suitable habitat. Holt and Leasure (1993) speculate that mammalian predation of eggs and nestlings could be the cause. An increase in populations of feral cats and dogs or coyotes, in combination with urbanization, likely seriously impacts this species reproductive success. These factors may be influencing local breeding populations near Boundary Bay and on Sea Island as both areas are popular with dog owners, and coyotes are now established at both locations.

Habitat threats

In British Columbia, the primary threat to this species is loss or degradation of old-field winter habitat (Butler and Campbell 1987; Campbell et al. 1990). The Fraser River delta supports the largest winter population of Short-eared Owls in the province. However, this area has been, and continues to be, modified through urbanization and increasingly intensive agricultural practices (Campbell et al. 1990). Habitat loss leads directly to a reduction in food availability causing an increase in intra- and interspecific competition (e.g., with Northern Harriers). Ongoing loss and fragmentation of habitat make new prey supplies harder to find (Cadman 1994).

Although the Short-eared Owl's breeding range in British Columbia is more widespread than its winter range, loss of nesting habitat can have an impact on local populations. Nesting habitat is especially subject to pressure from urbanization and modern agricultural practices in the Fraser and Okanagan valleys (Campbell et al. 1990). In more remote areas, nesting habitat may be degraded from overgrazing by livestock, or nests may be destroyed by mowing of meadows for hay.

Legal Protection and Habitat Conservation

The Short-eared Owl, its nests, and its eggs are protected from direct persecution in British Columbia under the provincial *Wildlife Act*.

Breeding habitat in British Columbia is associated with agricultural areas in the lower Fraser River Valley, Okanagan Valley, Thompson, and Peace lowlands. Undoubtedly, these owls also breed locally in more remote areas as well. Although a small area of wintering and breeding habitat in the lower Fraser River Valley is protected in the Alaksen National Wildlife Area, Boundary Bay Reserves, and Centennial Park (all in Delta), most of the wintering habitat in the lower Fraser River Valley, Okanagan Valley and Thompson is on private land. Delta farmers (Delta Farmland and Wildlife Trust) have an old-field management program that they operate in co-operation with the Canadian Wildlife Service; this program may help provide suitable habitat for this species on private agricultural land. Conservation of habitat on Crown land may be partially addressed by range use guidelines.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain important habitat features (i.e., tall grass) at traditional winter, roosting, or nesting locations.

Feature

Although Short-eared Owls tend to be nomadic, they may traditionally use areas for breeding, roosting, or wintering. Establish WHAs at traditional communal (>8 owls) roosting sites, traditional nest, or winter areas.

Size

WHAs for traditional (used for several years) roost sites will generally be 5 ha and WHAs for traditional nest sites or wintering sites will generally be 10 ha but will depend on site-specific factors.

Design

The WHA is not intended to encompass the entire area used by the owls but rather is intended to maintain key areas used for nesting, roosting, or foraging. Where appropriate, centre WHA on the known nest or roost sites.

General wildlife measure

Goals

1. Minimize human and livestock disturbance to active winter roosts and nest sites.
2. Maintain important structural features. For example, maintain a range of mid-height to tall grasses with some low shrub cover for nesting.

Measures

Access

- Do not construct roads.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to maintain the desired structure of plant community (i.e., tall grass), desired stubble height and browse utilization. Establish a key area to monitor structure, height, and utilization. If damage from livestock is found to be degrading the vegetative structure, fencing may be required. Consult MWLAP for fencing arrangements.
- Maintain grass structure (i.e., 50 cm or depending on the site's potential).
- Delay burning or mowing until after the breeding season (1 August).

Additional Management Considerations

Where possible, control forest encroachment into natural grassland habitat with controlled prescribed burning or other methods. Use prescribed burning in forest clearings where Short-eared Owls are nesting. Burning should occur outside of the breeding season.

In agricultural areas:

- Increase percentage of fields left fallow within winter range.
- Leave patches of shrubs and hedgerows between fields.
- Minimize disturbance by people and dogs during critical times (i.e., April through May; December through February).
- Enhance habitat for voles and other microtines, wherever possible.
- Consider fencing high use areas or known nesting areas to protect from management activities such as haying.

Old-field habitat is usually on private land. Due to the importance of old-field winter habitat for this species, landowners should be encouraged to retain or rotate fields in such a way as to maintain as much of this habitat as possible. Fields known to be used by Short-eared Owls should be managed to minimize negative impacts of disturbance by humans, vehicular traffic, and domestic animals.

Grassland, marshes, rangeland, and estuaries suitable for Short-eared Owl winter or nesting habitat should have appropriate vegetation characteristics retained and should be protected from undue disturbance by human activities.

In grassland areas, meadows should not be burned or mowed until >1 August to protect eggs and unfledged young.

Maintain a mosaic of grassland and old field habitat in suitable condition to ensure a continued supply of nesting and wintering habitat.

Information Needs

1. Status of breeding and wintering localities.
2. Impacts of human recreational use of nesting areas on reproductive success.
3. Suitability of clearcuts for foraging and nesting habitat.

Cross References

Sandhill Crane

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Personal Communications

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Spotted Owl

Strix occidentalis

Original by Ian Blackburn and Stephen Godwin

Species Information

Taxonomy

Three subspecies are recognized: Mexican Spotted Owl (*Strix occidentalis lucida*), California Spotted Owl (*S. occidentalis occidentalis*), and Northern Spotted Owl (*S. occidentalis caurina*) (Dawson et al. 1986; Wilcove 1987). Starch-gel electrophoresis was unable to detect variation between *S. occidentalis occidentalis* and *S. occidentalis caurina*; however, *S. occidentalis lucida* did show variation, suggesting the possibility of two distinct species (Barrowclough and Gutierrez 1990). In addition, two separate evolutionary histories have been demonstrated by the major allelic frequency difference between *occidentalis*/*caurina* and *lucida* (Barrowclough and Gutierrez 1990).

Description

The Spotted Owl is considered a medium-sized owl with an average height of about 45 cm, and average wingspan of about 90 cm. The plumage consists largely of dark brown body feathers with a regular pattern of round to elliptical white spots, white horizontal bars on the chest and tail, large dark brown eyes surrounded by tawny facial disk, and no ear tuffs. Male and female Spotted Owls have similar plumage. Females may be distinguished by their comparatively larger body size (females: $n = 65$, mean = 663 g, SD = 42.8 g; males: $n = 68$, mean = 579 g, SD = 34.9 g; Blakesley et al. 1990), and higher pitch of their vocalization (Forsman et al. 1984).

Distribution

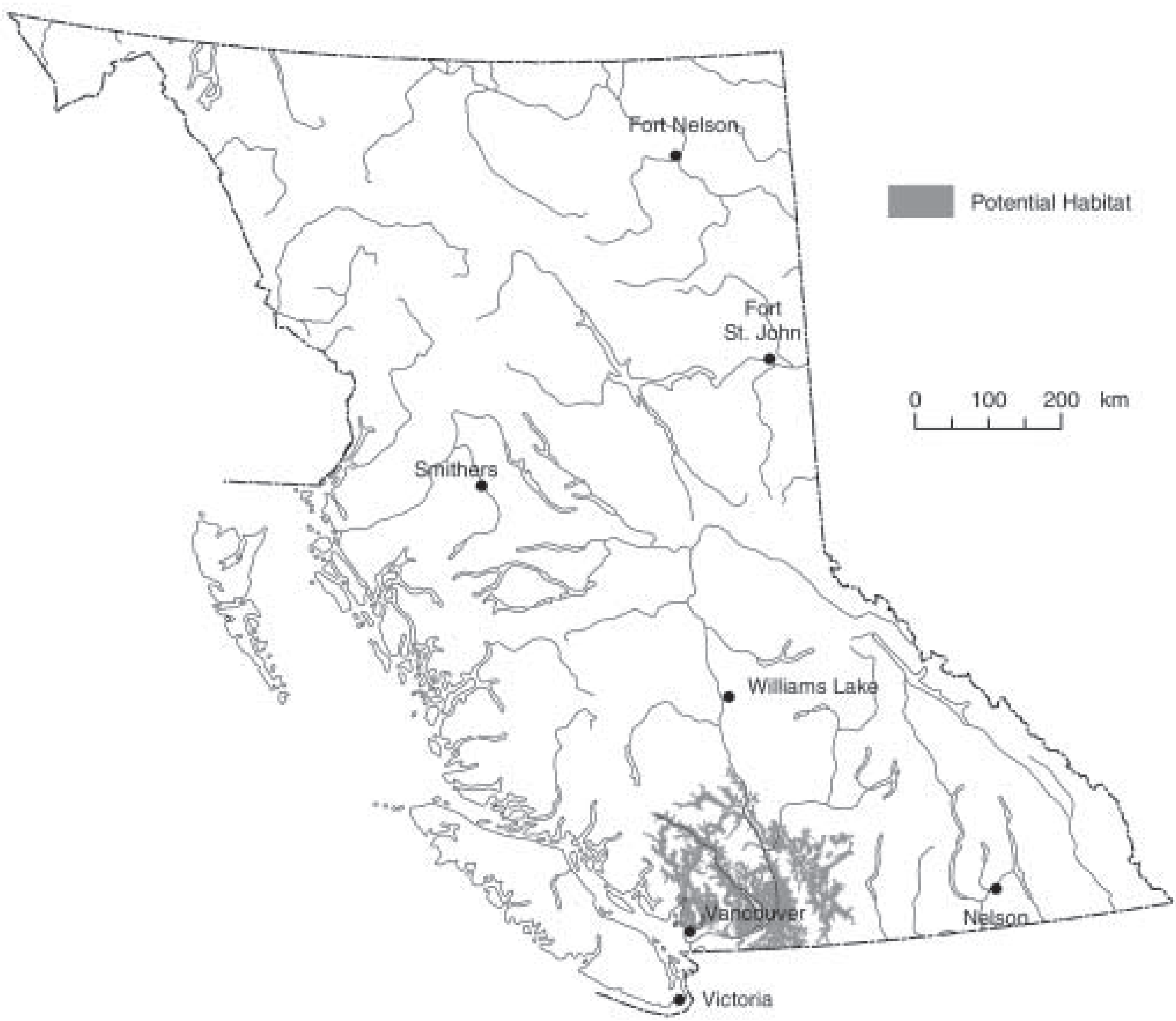
Global

The Spotted Owl occurs from southern British Columbia south to central Mexico. The Mexican Spotted Owl ranges from southern Utah and central Colorado, south through the mountainous regions of Arizona and New Mexico; Guadelupe Mountains of western Texas; mountains of northern and Central Mexico south to Michoacan and Guanajuato. The California Spotted Owl ranges from southeastern Shasta County, south through the Sierra Nevada to Kern County, through the Coast Ranges from Monterey County to San Diego County to northern Baja California (Sierra San Pedro Martir). The Northern Spotted Owl ranges from southwestern mainland British Columbia, western Washington, western Oregon, to northwestern California.

British Columbia

Based on historic (pre-1985, n=28) and recent ($n = 65$) records, the current known range of the Spotted Owl in British Columbia extends from the international border north about 200 km to Carpenter Lake, and from Howe Sound and Pemberton east about 160 km to the slopes of the Cascade Mountain range (MWLAP 2003). There are unconfirmed historic records occurring as far northwest as Bute Inlet in the Sunshine Coast Forest District (Laing 1942). Although the Spotted Owl occurred historically in the lowlands of the lower Fraser River Valley, the species is thought to be extirpated from this area as a result of the extensive loss of old forests due to urbanization, agriculture, and forestry. Despite relatively recent historic records, survey efforts conducted between 1992 and 1997 in the Squamish and Whistler corridor were

Spotted Owl
(Strix occidentalis)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several classifications (Forest Cover Data and Biogeoclimatic) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

unsuccessful at detecting Spotted Owls, suggesting that the species may have become locally extirpated in this area. The full extent of the range of Spotted Owls in British Columbia is still unknown. Inventories are still required to assess the western, northern, and eastern extent of the species range.

Forest region and districts

Coast: Chilliwack, Squamish

Southern Interior: Cascades

Ecoprovinces and ecosections

COM: EPR, NWC, SPR

GED: FRL

SOI: LPR, HOR

Biogeoclimatic units

CWH: dm, ds1, mm1, ms1, ms2, vm1, vm2

ESSF: mw

IDF: dk2, ww

MH: mm1

Broad ecosystem units

AU, AV, CD, CH, CW, DF, DL, EW, FR, IH, MF, RD

Elevation

~0–1370 m

Life History

Diet and foraging behaviour

Spotted Owls are nocturnal and considered a sit and wait predator that moves from perch to perch waiting to detect prey. Spotted Owls primarily prey on small mammals, although they have been known to predate on a broad array of taxa including birds, amphibians and insects (Forsman et al. 1984). The composition of their diet varies among regions and forest types. In general, their diet includes flying squirrels, deer mice, tree voles, woodrats, red-backed voles, and hares. Pellet analysis of Spotted Owls in British Columbia revealed the largest contribution (41.2%) to the owl's diet is Northern Flying Squirrels (*Glaucomys sabrinus*) and bushy-tailed woodrats (*Neotoma cinerea*) (27.8%; Horoupian et al. 2000), which is consistent with other studies throughout the species range (Forsman et al. 1984; Forsman et al. 2001). Flying squirrels are also nocturnal, and tend to be more abundant in old forests than in young forests; however, their density in old forests is low (Carey et al. 1992). In British Columbia, Ransome (2001) found the density of Flying Squirrels in old forest in the wet coastal ecosystem to be 1.5 ± 1.8 squirrels/ha (range 0.3–2.9) and in second-growth stands to be 1.0 ± 1.4 squirrels/ha (range 0.06–1.8). Although the densities in British Columbia were not significantly different, the results suggest densities of flying squirrels may be higher in old forests. Even a potential 0.5 squirrel/ha more in old forest than second growth could translate to significantly more squirrels within a home range and improve the owls' likelihood of survival and reproduction. Due to this low density of prey, the Spotted Owl requires large amounts of old forest for foraging (Carey et al. 1992).

Reproduction

Spotted Owls are typically monogamous, although evidence suggests a low, but frequent occurrence of separation between pairs (Forsman et al. 2002). In late winter, Spotted Owls begin roosting together near the nest 4–6 weeks prior to egg laying, with copulation generally occurring 2–3 weeks before nesting (Forsman et al. 1984). The average clutch size is two owlets ± one owlet. The incubation period is estimated to be approximately 30 days ± 2 days (Forsman et al. 1984). Females incubate and brood the juveniles while the males provide food for both females and juveniles (Forsman et al. 1984). Most juveniles leave the nest when they are 34–36 days old. Although the mean date when juveniles left the nest varied among years, Forsman et al. (2002) reported mean dates of June 8 ± 0.53 days in Oregon (n = 320 owls, range May 15 to July 1) and June 18 ± 1.67 days in Washington (n = 77, range May 13 to July 15). Similar to Washington, juveniles at two locations in British Columbia were observed off the nest between June 15 and June 20 (Hobbs 2002); however, juveniles have been observed off the nest in British Columbia as early as on June 7 (D. Dunbar, pers. comm.). The results support Forsman et al. (1984) that nesting typically occurs earlier in southern portions of the species range in

North America. In Washington and Oregon, renesting after a nest failure was rare, only occurring 1.4% of the time after an initial failure (Forsman et al. 1995).

In Washington and Oregon, Forsman et al. (2002) reported that 22% of males and 44% of females were paired at 1 year of age; however, only 1.5% of 1-year-old males and 1.6% of 1-year-old females actually bred. Typically, Spotted Owls begin breeding at 3 years of age. Franklin et al. (1999) note that fecundity appears to vary over time with evidence of a bi-annual cycle where by more young fledged in even years than odd years (even/odd effect). The cause of this cyclic pattern is unknown, but may be linked to weather or prey populations (Franklin et al. 1999).

Site fidelity

Spotted Owls typically have strong fidelity to breeding sites and tend to occupy the same geographic area for long periods of time (Forsman et al. 1984). Forsman et al. (2002) observed a minimum 6% of non-juvenile owls changed territories annually. The frequency of these non-juvenile movements was higher for female owls, younger owls, and owls without a mate or who had lost their mate through death or separation in the previous year. In the Olympic Mountain range in Washington, owl pairs changed nests in 75% of sequential nesting attempts; 40% returned to a nest used previously (Forsman and Giese 1997). The median distance between these alternate nests was 0.52 km (range 0.03–3.35 km; $n = 92$).

Home range

Home range sizes vary by geographic location, with a general increasing trend from southern to northern portions of the species range (Thomas et al. 1990). For example, home range sizes have been reported as small as 549 ha for a single owl in Oregon (Forsman et al. 1984) and as large as 11 047 ha for a pair of owls in Washington (Hanson et al. 1993). The size of an owl's home range depends on many factors including food availability; interspecific and intraspecific competition; presence of predators; and the quantity, quality, and dispersion of suitable habitats (USDI 1992). For example, decreasing the density of suitable habitat or prey populations within the landscape may result in an increase in home range size as owls expand their foraging area to find sufficient amounts of habitat with prey.

In Washington, the median annual home range for a pair of owls for the west side and east side of the Cascade Mountain range was estimated at about 3321 ha (range 1302–7258 ha) and 2675 ha (range 1490–6305 ha), respectively, with a total suitable habitat composition of 67% and 71%, respectively (Hanson et al. 1993). In British Columbia, annual home range estimates for 3 pairs of owls in the drier ecosystem ranged from 1732 to 4644 ha, with suitable habitat compositions ranging from 60 to 66% (A. Hilton, pers. comm.). However, these home ranges for British Columbia are likely underestimated due to the small sample size and limited seasonal tracking duration. Annual home range sizes for British Columbia are likely comparable to those in Washington, if not slightly larger.

Forsman et al. (1984) observed an average 68% home range overlap between paired individuals. Despite this overlap, paired individuals used the same locations for foraging only 4–10% of the time, suggesting little competition for food between paired individuals. In contrast, adjacent, non-paired individuals overlap their home ranges by about 12% where both owls tend to spend relatively small portions of their time in the periphery of their home range (Forsman et al. 1984).

Movements and dispersal

Juveniles are obligate dispersers and typically leave their natal area by September 19 (95% CI, September 17 to 21) in Oregon and September 30 (95% CI, September 25 to October 4) in Washington (Forsman et al. 2002). In British Columbia, the latest date that juveniles owls were observed with their parents was September 28 (2 records; MWLAP 2003), suggesting that the initial date of dispersal is likely similar to Washington. The direction of dispersal appears random; however, it may be influenced by barriers such as high elevation terrain, large bodies of water, and large open areas of unsuitable habitat (Thomas et al. 1990; Miller et al. 1997; Forsman et al. 2002). Distances between the natal area and where the owls eventually settled ranged from 0.6 to 111.2 km apart; however, the distribution of distances were skewed towards shorter distances (Forsman et al. 2002). Female juveniles typically disperse farther than males, with 50% of female and male juveniles settling within 22.9–24.5 km and 13.5–14.6 km from their natal areas, respectively (Forsman et al. 2002).

Habitat

Structural stage

6: mature forest
7: old forest

Important habitats and habitat features

Nesting

Spotted Owls do not create their owl nest structures, but use a variety of pre-formed structures that includes cavities in the side and top of trees, and platforms constructed by other birds or by natural accumulations of debris (Forsman et al. 1984; Dawson et al. 1986; Buchanan et al. 1993; Forsman and Giese 1997). Nest structures are about 50 cm in diameter, and typically do not differ in size by nest type or geographic region (Forsman and Giese 1997). However, tree species and size of nest trees (dbh) are geographically variable and selection is thought to be based largely on the availability of suitable cavities and platforms. Regardless of geographic region, cavity nests were in trees with greater diameters than platform nests (Table 1).

In wetter ecosystems, Spotted Owls primarily nest in cavities in large diameter trees typically found in old forest stands or younger stands with residual large diameter old trees (Thomas et al. 1990; Forsman and Giese 1997). In the Olympic Mountain range, nest trees averaged 136.6 cm dbh and were predominantly western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), and Douglas-fir (*Pseudotsuga menziesii*) ranging from 114 to 1189 m in elevation. In drier ecosystems, Spotted Owls nest in a wide range of forest stand ages (n = 62, median age = 147 yr, range 66–700 yr; Buchanan et al. 1993) and forest structures. On the eastern slopes of the Cascade Mountain range in Washington, nest trees averaged 66.5 cm dbh and were found almost exclusively in Douglas-fir trees ranging from 381 to 1463 m in elevation (Buchanan et al. 1993, 1995). In contrast to wetter ecosystems, 84% (n = 85) of Spotted Owl nests were on platforms in trees created by abandoned Northern Goshawk (*Accipiter gentilis*) nests (n = 47) or mistletoe brooms (n = 21), with only 16% of nests found in cavities or tops of trees (Buchanan et al. 1993). In British Columbia, nests have been similarly found in cavities of large diameter living western redcedar, western hemlock, and Douglas-fir trees, in tops of large diameter dead Douglas-fir snags, and in abandoned Northern Goshawk nests.

Foraging

Three habitat types have been defined in Washington based on their use by Spotted Owls for nesting, roosting and foraging (Hanson et al. 1993). Superior habitats are preferred by Spotted Owls as these habitats are used by the owl in greater proportion than the availability of this habitat type in the landscape. Moderate habitats are used by Spotted Owls in equal proportion to the availability of this habitat type in the landscape. Marginal habitats are used less than this habitat type's availability in the landscape, and are considered unsuitable for sustained use by Spotted Owls. Table 2 defines the stand characteristics for superior and moderate habitats for the wetter and drier ecosystems.

Spotted owls are a sit and wait predator that usually roost within or adjacent to forest stands used for foraging. The structural diversity found in superior habitat type provides for numerous roosting and foraging perches at various heights in the canopy and understorey. The openness of these stands allow for greater maneuverability within the canopy layers and greater access to prey. These open stands tend to possess higher quantities of understorey shrubs and herbs that support higher densities of prey. The characteristics of superior habitat is predominantly found within old forest (forests >140 yr); however, some younger forests, particularly in drier ecosystems, may also possess these characteristics.

Table 1. Comparison of nest tree diameter at breast height (dbh), tree height, and nest diameter among three geographic regions in Washington and Oregon

	Cavity nests			Platform nests		
	n	mean	SD/SE	*n*	mean	SD/SE
Washington Olympic Mountains – (Forsman and Giese 1997)						
dbh (cm)	99	141.8	6.15 SE	11	88.7	15.74 SE
Tree height (m)	95	40.7	1.36 SE	11	39.8	3.99 SE
Nest diameter (cm)	76	45.3	1.15 SE	10	48.0	4.59 SE
Washington Eastern Slopes of Cascade Mountains – (Buchanan et al. 1993)						
dbh (cm)	14	94.7	23.1 SD	71	59.4	21.8 SD
Tree height (m)		Not reported			Not reported	
Nest diameter (cm)		Not reported			Not reported	
Oregon – (Forsman et al. 1984)						
dbh (cm)	28	135.0	6.03 SE	16	106.0	11.93 SE
Tree height (m)	28	38.1	2.37 SE	16	42.0	3.42 SE
Nest diameter (cm)	20	50.0	0.93 SE	8	62.0	1.32 SE

Table 2. Suitable Spotted Owl habitat definitions for British Columbia (SOMIT 1997)

Superior habitat (nest, roost, forage and dispersal)	**Moderate habitat** (roost, forage, and dispersal)
Wetter ecosystems: maritime CWH and MH biogeoclimatic zones (CWHdm, CWHvm1, CWHvm2, MHmm1)	
• ≥3 canopy layers, multi-species canopy dominated by large (>75 cm dbh) overstorey trees (typically 37–185 stems/ha) • moderate to high (60–80%) canopy closure • ≥5 large (>50 cm dbh) trees/ha with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections) • ≥5 large (>75 cm dbh) snags/ha. • accumulations (≥268 m^3/ha) of fallen trees and other CWD on ground	• ≥2 canopy layers, multi-species canopy dominated by large (>50 cm dbh) overstorey trees (typically 247–457 stems/ha, although densities as low as 86 stems/ha are possible where large diameter trees are present) • moderate to high (60–80%) canopy closure • ≥5 large trees/ha (>50 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections) • ≥5 large (>50 cm dbh) snags/ha • accumulations (≥100 m^3/ha) of fallen trees and other CWD on ground
Drier ecosystems: sub-maritime CWH and MH, IDF, and ESSF biogeoclimatic zones (CWHds1, CWHms1, CWHms2, MHmm2, ESSFmw, IDFww)	
• ≥3 canopy layers, multi-species canopy dominated by large (>50 cm dbh) overstorey trees (typically 173–247 stems/ha, although densities as low as 86 stems/ha are possible where large diameter trees are present) • moderate to high (60–85%) canopy closure • ≥5 large trees/ha (>30 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections) • ≥7 large (>50 cm dbh) snags/ha. • accumulations (≥268 m^3/ha) of fallen trees and other CWD on ground	• ≥2 canopy layers, multi-species canopy dominated by large (>30 cm dbh) overstorey trees (typically greater than 247 stems/ha) • stands must contain 20% Fd and/or Hw in the overstorey • >50% canopy closure. • ≥5 large trees/ha (>30 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections) • ≥5 large (>30 cm dbh) snags/ha • accumulations (≥100 m^3/ha) of fallen trees and other CWD on ground

Conservation and Management

Status

The Spotted Owl is on the provincial *Red List* in British Columbia. It is considered *Endangered* in Canada (COSEWIC 2002). The "Northern" Spotted Owl is federally designated as Threatened throughout its entire range in the United States under the U.S. *Endangered Species Act*.

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	CA	OR	WA	Canada	Global
S1	S2	S3	S3	N1	G3T3

Trends

Population trends

Blackburn et al. (2002) estimated the historic (pre-European settlement) Spotted Owl population size in British Columbia as about 500 pairs of owls. Between 1992 and 2001, the Spotted Owl population declined by about 49% at an average annual rate of -7.2% (± 1.7% for 90% CI; Blackburn et al. 2002). Survey results from 2002 suggest that the population declined by an additional 35% between 2001 and 2002. Combined, the Spotted Owl population has declined by about 67% since 1992 at an average rate of -10.4%/yr (Blackburn and Godwin 2003). Applying this observed decline to the fewer than 100 pairs of owls estimated in British Columbia in the early 1990s (Dunbar et al. 1991) suggests that the current Spotted Owl population in British Columbia may be fewer than 30 pairs of owls. It is reasonable to assume that the extirpation of the Spotted Owl from British Columbia is imminent if the observed annual rate of decline continues (Blackburn et al. 2002).

The observed large decline is Spotted Owl numbers is not exclusive to British Columbia. In the United States, monitoring of Spotted Owls at 15 different demographic study areas between 1985 and 1998 suggests a range-wide annual population decline of -3.9% (± 3.6% for 95% C.I.; Franklin et al. 1999).

Habitat trends

Since European settlement, timber harvesting for urbanization, agriculture, and resource extraction has occurred, with almost the entire forested area in the lower Fraser River Valley converted to non-forest uses. It is estimated that suitable habitat represents about 50% of the current capable forested area in the two forest districts (Blackburn et al. 2002). Some of these habitats are currently unusable by Spotted Owl due to their small patch size, isolation from other habitat patches, or distribution in landscapes with suitable habitat densities too low to support the species. Over the next 25 years, the rate of habitat loss caused by timber harvest and natural disturbance is expected to exceed the recruitment of suitable habitat from young forests, resulting in further fragmentation and isolation of habitats available to the owl (Blackburn and Godwin 2003).

Threats

Due to their small population size and low densities, Spotted Owls in British Columbia are vulnerable to extirpation. Factors that threaten the species can be divided into primary and secondary factors (Blackburn and Godwin 2003). Primary factors cause long-term sustained effects that limit the carrying capacity, or total capable population size. Primary factors include habitat loss and fragmentation, competition with Barred Owls (*Strix varia*), and global warming. Secondary factors cause short-term effects in population size, but the population recovers from these factors relatively soon after the influence of the factor changes to a more favourable condition. Secondary factors include stochastic environmental and demographic events, genetic variability, predation, disease, parasites, and viruses. Although primary factors limit population size and may cause extirpation, secondary factors are likely the leading cause of extirpation of small populations.

Population threats

Since the 1960s, Barred Owls have invaded the range of the Spotted Owl. Although some niche segregation is evident (Hamer et al. 1989), Barred Owls likely exclude Spotted Owls from utilizing some mature and old forests found within core Barred Owl territories. As well, the presence of both species within the same geographic area may suppress prey populations. The combined competitive effect of habitat exclusion and prey suppression may cause Spotted Owls to increase their home range size to compensate for this loss, or cause the displacement of Spotted Owls as they leave their territory to find new territories with less competition (Kelly 2001). In addition to these competitive effects, the low occurrence of cross breeding between Spotted Owls and Barred Owls negatively impacts the reproductive success of the Spotted Owl population by effectively removing adult Spotted Owls from the pool of potential breeders.

Catastrophic environmental events such as fire, windstorms, and insect outbreaks may eliminate both habitat and Spotted Owls that they support (Thomas et al. 1990). As well, severe weather events may cause poor reproductive performance or high adult mortality, resulting in periodic gaps in the demographic profile. If the population cannot recover from these events, the population may continue to decline to extirpation as future stochastic events occur.

Isolated small populations are prone to decreased genetic variability caused by founder effects, increased incidence of inbreeding, and/or genetic drift. Isolated populations may have higher incidences of adult and juvenile mortality caused by pronounced deleterious recessive genes, reduced adaptability to environmental change, and/or higher susceptibility to disease. Furthermore, closely related individuals may not mate at all, thereby reducing the productivity and recruitment of the population. Decreasing population size and increasing isolation of individuals and populations places the Spotted Owl population in British Columbia at greater risk of extirpation caused by the loss of genetic variability.

Spotted Owls are incidental prey to several predators including Great Horned Owls (*Bubo virginianus*) and Northern Goshawks. Ravens are also predators, more likely preying on very young owls and eggs rather than adult owls. Some researchers also include Barred Owls as a possible predator, although evidence is limited (Kelly 2001). Most predation of individuals is thought to occur during juvenile dispersal, when young owls are inexperienced and searching for new habitats. Perhaps the increasing abundance of unsuitable habitats within the landscape has increased the exposure of dispersing Spotted Owls to predators as they move through these unsuitable habitats resulting in an increased rate of mortality. For predators to be the main cause of the population decline requires the rate of mortality to be higher than normal mortality rates caused by predation.

Spotted Owls are prone to disease, parasites, and viruses; however, these seldom result in sufficient mortality to cause population declines. Of recent concern is the range expansion of the West Nile Virus. The West Nile Virus is usually transmitted to birds through mosquitoes, where once established in a bird, mortality may follow. Those that survive may act as carriers to help spread the virus. Although the West Nile Virus does not occur within southwestern British Columbia, it likely is only a matter of time before it does. Its potential impact on the Spotted Owl is not known; however, there is a risk that it could cause further declines in Spotted Owl numbers in British Columbia.

Habitat threats

Habitat is threatened by timber harvesting, urbanization, and natural disturbances such as fire, wind, insects, and diseases. Habitat loss and fragmentation may increase the risk of mortality caused by predation and exposure of owls that must move through unsuitable habitats to reach other suitable habitats. Within an owl's territory, habitat loss and fragmentation may cause the resident owls to increase their home range size to compensate for this habitat loss and need to find sufficient prey. As well, habitat loss and fragmentation may reduce the reproductive success and adult survivorship as adult owls must expend more energy to find food farther away from their core area. Eventually continued habitat loss and fragmentation within a home range will surpass the minimum threshold needed to sustain owls, and the area will remain vacant from Spotted Owls until habitats are restored. As a result, the number of potential territories available in the landscape is reduced. Isolation of territories occurs as the interspatial distances between territories exceed the maximum distance needed for successful dispersal. Without successful dispersal, isolated territories and populations will eventually decline to extirpation.

Legal Protection and Habitat Conservation

The Spotted Owl, its nests, and its eggs are protected under the provincial *Wildlife Act.*

A Spotted Owl Recovery Team was formed in 1990 to develop a recovery plan for the species. At the request of the provincial government, the recovery team developed a range of management options that spans the scale from minimum to maximum protection for Spotted Owl with correspondingly minimum to maximum socio-economic consequences (Dunbar and Blackburn 1994). In 1997, the provincial Cabinet approved the Spotted Owl Management Plan (SOMP) with the goal of achieving a reasonable level of probability that owl populations will stabilize, and possibly improve, over the long term without significant short-term impacts on timber supply and forest employment. The SOMP recognizes that the Spotted Owl population will continue to decline over the next 20–30 years with a 60% chance of the population stabilizing, and possibly improving its status over the long term. Timber supply impacts of SOMP are estimated at between 3 to 5% reduction in allowable annual cut. The SOMP includes a strategic and operational guidelines component, and Resource Management Plans. The strategic component describes the strategic objectives and policies for Spotted Owl management in 21 special resource management zones (SRMZs) totalling about 363 000 ha) identified for the long-term conservation of the species. The operational guidelines component provides resource managers with further guidance for developing long-term Resource Management Plans within SRMZs, and forest practices that will create or retain forest attributes critical for Spotted Owl survival. Resource Management Plans demonstrate how, over a long-term planning horizon of one or more forest rotations, the Spotted Owl and forest management objectives and policies will be achieved in each SRMZ. Resource Management Plans identify landscape and stand level management strategies that are expected to best protect suitable habitat and to provide forestry, economic and employment opportunities.

The 21 SRMZs include 159 000 ha of protected areas (includes capable/suitable habitats within the Greater Vancouver Watershed Districts: Seymour, Capilano, and Coquitlam; protected areas: Seymour, Cypress, Garibaldi, Golden Ears, Sasquatch, Manning, Skagit, Pinecone/Burke Mountain, Birkenhead Lake, Mehatl Creek, and Liumchen) and 204 000 ha of Crown forest land. The SRMZs are spaced a maximum 20 km apart to provide a reasonable chance that owls can disperse from one SRMZ to another. Each SRMZ varies in size and contains between 2 to 13 Long-term Activity Centre (LTACs), each about 3200 ha and capable of sustaining a breeding pair of Spotted Owls in the future. The long-term stabilization, and possible improvement, of the Spotted Owl population is dependent upon maintaining, or restoring, a minimum 67% of the gross forested area as suitable habitat (i.e., forests >100 years old, taller than 19.4 m, and below 1370 m) in each LTAC. Of the 101 LTACs identified within SRMZs, only 55 LTACs currently meet the minimum 67% habitat target. Recruitment of habitat up to this minimum target in the other 45 LTACs may require up to 60 years.

The SOMP provides temporary protection for an additional eight activity centres (referred to as Matrix Activity Centres) that are found entirely or partially outside of SRMZs. These Matrix Activity Centres are to be phased out by allowing, over a

50-year period, limited clearcutting of suitable habitat at a similar rate as suitable habitat is recruited within SRMZs. However, some Matrix Activity Centres will be phased out sooner to achieve forest company timber needs to offset the impacts associated with the creation of the Mehatl Creek Protected Area (SOMIT 1997).

The SOMP does not provide protection over existing provisions of the *Forest and Range Practices Act*, to Spotted Owl activity centres found outside of SRMZs, Matrix Activity Centres, and protected areas discovered after June 1995. Since June 1995, 19 Spotted Owl activity centres have been discovered and remain unprotected. Fourteen of these occur farther north beyond the managed range of SOMP, eight of which occur in the Cascades Forest District (formerly the Lillooet Forest District).

Due to concern over the Endangered status and immediate threat of extirpation, a Spotted Owl Recovery Team was re-established in 2002 to develop a Recovery Plan including assessing the SOMPs effectiveness for stabilizing the population. Completion of the Spotted Owl Recovery Plan is expected by 2005.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Due to the status of the Spotted Owl in British Columbia, all individual owls are critical to the recovery of the species and should be considered for protection. The following recommendations may be considered within strategic level planning processes. These recommendations are consistent with the Spotted Owl Management Plan, and its associated documents, and are recommended for the management of habitat to sustain a pair of Spotted Owls (see SOMP for more information). These management provisions may change pending the implementation of a Spotted Owl Recovery Plan or other direction from government.

- ❖ Maintain suitable Spotted Owl habitat (i.e., coniferous forest >100 years old, >19.4 m tall and <1370 m elevation).
- ❖ Maintain LTACs throughout the range of the Spotted Owl.
- ❖ Where possible aggregate LTACs into clusters of multiple breeding territories.
- ❖ Where possible the distance between LTACs and clusters of LTACs should be <20 km.
- ❖ Where the distance between LTACs is >20 km, consider establishing an additional LTAC to ensure habitat connectivity to facilitate dispersal.
- ❖ Maintain or restore suitable habitat within LTACs.
- ❖ Wherever possible and practicable, overlap LTACs with other constrained areas (i.e., protected areas, non-contributing areas) to minimize timber supply impacts.

Wildlife habitat area

Goal

Maintain areas of suitable habitat throughout the range of the Spotted Owl.

Feature

Establish WHAs at resident Spotted Owl areas consistent with current government direction. WHAs may be established to legalize existing LTACs under FRPA, to modify existing LTACs, to protect new resident Spotted Owl areas or to protect other habitat for recovery.

Size

The size of the WHA will generally be 3200 ha of forested area.

Design

The WHA should include a core area(s) (80 ha), and a management zone which includes a long-term owl habitat area (light volume removal) and a forest management area (heavy volume removal). The WHA should include an 80 ha core area around all known nesting or roosting sites. The WHA should also include a minimum of 67% suitable habitat (i.e., coniferous forest >100 years old, >19.4 m tall and <1370 m). The long-term owl habitat areas (LTOHAs) define where, over the long term, the minimum 67% suitable habitat target will be maintained or restored within each WHA. The forest management areas (FMAs) define where, over the long term, timber harvesting can occur to reduce the amount of suitable habitat as low as the 67% habitat target for the WHA.

General wildlife measures

Goals

1. Protect known nest and roost areas. Recruit suitable nesting and roosting habitat and habitat structures.
2. Minimize disturbance at known nesting and roosting sites.
3. Maximize forest interior habitat.
4. Create, enhance, or maintain suitable habitat (i.e., multi-layered, variable density, multi-species stand structure with canopies dominated by dominant and co-dominant trees within areas).
5. Maintain important habitat features (e.g., coarse woody debris, wildlife trees, interior forest, large diameter trees, moderate to high canopy closure; see Table 2).
6. Maintain or enhance habitat for prey species.

Measures

Access

- Do not construct, modify, or deactivate roads or landings within the core area. Where approved, do not construct, modify or deactivate between 1 March and 31 July.
- Minimize road clearing widths to ≤3 m between the timbers edge and either the toe of the fill or the top of the cut, unless no other practicable option exists.

Harvesting and silviculture

- Do not harvest or salvage within core area(s).
- Do not salvage in the management zone.
- Do not remove non-timber forest products.
- Maintain or restore at least 67% of the gross forested area within the WHA in suitable owl habitat of which 75% should be maintained or restored as superior habitat (>140 years, >19.4 m tall and <1370 m). When there is <67%, do not harvest the next oldest age class and/or stands that best achieve Spotted Owl habitat distribution objectives. Heavy volume removal is permitted within the FMA when WHA includes >67% suitable habitat.
- Distribute the 67% suitable habitat into large unfragmented patches >500 ha that are connected by movement corridors of suitable habitat that are a minimum of 1 km wide.
- When harvesting in the management zone (LTOAC and FMA) implement the following measures:
  - Patch cuts (0.05–0.5 ha in size) can represent no more than 5% of the prescribed cut block. Patch cuts must be minimum 100 m (edge to edge) from adjacent patch cuts, clearcuts or natural openings >0.25 ha in size.
  - Remove up to one-third of the basal area from each 10 cm stand diameter class distributed evenly across the treatment area.
  - Retention of trees should be relatively evenly distributed throughout cut blocks. Timber extraction corridors will not exceed the average inter-tree spacing requirement of the treatment area as described in Table 3.
  - For cut blocks within CWHds1, CWHms1, CWHms2, MHmm2, ESSFmw, and IDFww, maintain or create on average 5 snags >30 cm dbh/ha and maintain existing coarse woody debris, and add 25 cubic m/ha of unmerchantable logs >30 cm dbh.
  - For cut blocks within CWHdm, CWHvm1, CWHvm2 and MHmm1, maintain or create on average 5 snags >50 cm dbh/ha and maintain existing coarse woody debris, and add 25 cubic m/ha of unmerchantable logs >50 cm dbh.

Table 3. Average corridor width spacing requirements for partial harvests

Retention of dominant trees/ha	Average corridor widths
173	7.6 m
200	7.0 m
250	6.3 m
300	5.8 m
400	5.0 m
500	4.5 m
625	4.0 m
800	3.5 m
1000	3.2 m

Pesticides

- Do not use pesticides.

Within the FMA

- Locate cut blocks in areas that minimize impacts to suitable habitat objectives and Spotted Owls activity.
- Maintain a minimum of 10% wildlife tree retention areas. Wildlife tree retention areas that consist of non-suitable habitat may be enhanced utilizing partial harvest.
- Maintain or create on average 5 snags >76 cm dbh/ha in CWHdm, CWHvm1, CWHvm2 and MHmm1, or maintain or create on average 5 snags >51 cm dbh/ha in the CWHds1, CWHms1, CWHms2, MHmm2, ESSFmw, and IDFww.
- For cut blocks within CWHds1, CWHms1, CWHms2, MHmm2, ESSFmw, and IDFww, there should be an average of 40 windfirm leave trees maintained from the top 80 largest diameter trees/ha.
- For cut blocks within CWHdm, CWHvm1, CWHvm2, and MHmm1, there should be an average of 15 windfirm leave trees maintained from the top 30 largest diameter trees/ha.

Information Needs

1. Current range and distribution in the province.
2. Short-term population changes and long-term population demographics.
3. Habitat selection/preference requirements.

Cross References

Bull Trout, Coastal Giant Salamander, Coastal Tailed Frog, Keen's Long-eared Myotis, Marbled Murrelet, Pacific Water Shrew

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Grasshopper Sparrow

Ammodramus savannarum

Original[1] prepared by Susan Paczek

Species Information

Taxonomy

Four subspecies of Grasshopper Sparrow are recognized in North America. Only *Ammodramus savannarum perpallidus* occurs British Columbia (Vickery 1996; Campbell et al. 2001).

Description

The Grasshopper Sparrow is small (11–13 cm, mass 14.5–20 g), flat-headed, and inconspicuous. The head has a dark, blackish crown that is narrowly streaked with buff and divided by a pale buffy-white crown stripe. Lores are orange-yellow, sometimes extending thinly over and behind the eyes. The bill is deep. Nape is greyish, with fine chestnut or reddish brown streaks. The back is streaked with chestnut-rust and black, with yellow wing edges that are brightest at the carpal joint. Tail is short and sharp, with rectrices pointed with bare shaft at tip (as is typical of *Ammodramus*). Breast is buffy and unstreaked, with a whitish lower breast. Juvenile Grasshopper Sparrows have a band of streaks across their breasts (Vickery 1996; Cannings 1995). Eggs are creamy white, speckled or spotted with reddish brown, and sometimes have greyish markings (Vickery 1996).

Distribution

Global

The breeding range of *A. savannarum perpallidus* extends from northwestern California, eastern Washington State, northeast and southwestern Oregon, southern British Columbia, Alberta, Saskatchewan, western Ontario and Minnesota, south to southwestern California, central Nevada, northern Utah, central Colorado western Oklahoma, and central Texas, and possibly east to Illinois and Indiana. Winter range extends from western Oregon, central California, west and southeast Arizona, central Oklahoma, southern Louisiana, southern Mississippi, and southwest Georgia, south to southern Baja California, Mexico, and El Salvador (Vickery 1996).

British Columbia

In British Columbia, the Grasshopper Sparrow is largely restricted to the Okanagan and lower Similkameen valleys, occurring mainly between Osoyoos Lake in the south, and Goose Lake north of Vernon, and west through Richter Pass to Chopaka in the southern Similkameen Valley (Campbell et al. 2001). A small breeding population has been recorded in the Nicola Valley near Chapperon Lake (Cannings 1995). Grasshopper Sparrows have occurred as a vagrant on the coast in the Fraser Lowland, and on Vancouver Island near Victoria. In the Interior, they have occurred as a vagrant at Becher's Prairie, west of Williams Lake (Campbell et al. 2001). Grasshopper Sparrows may also occur in the extreme southern Rocky Mountain Trench (Fraser et al. 1999).

Forest regions and districts

Southern Interior: Kamloops, Okanagan Shuswap

Ecoprovinces and ecosections

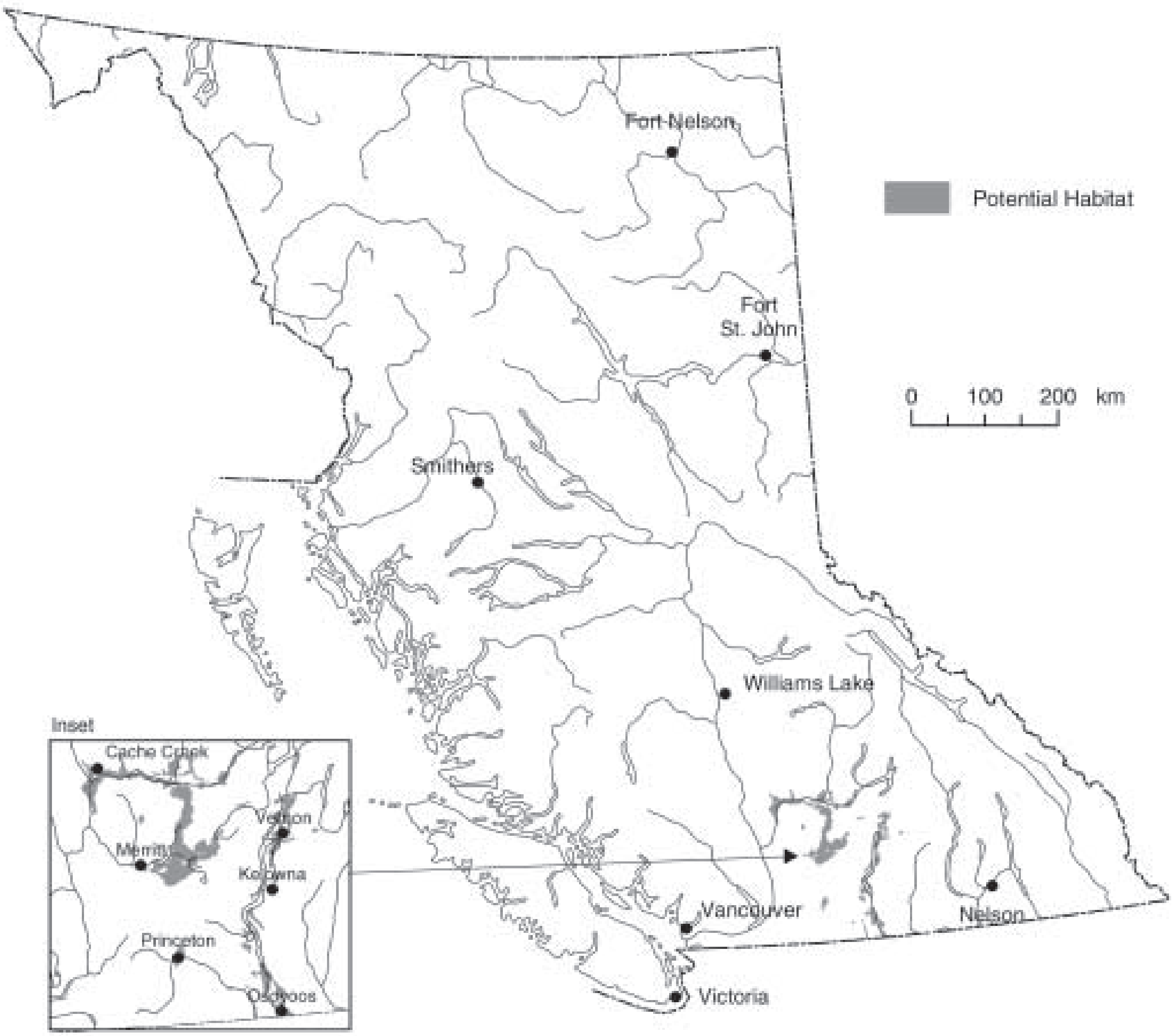
SOI: GUU, NIB, NOB, OKR, SOB, STU, THB

Biogeoclimatic units

BG: xh1, xh2, xw, xw1
IDF: dk1a, xh1, xh1a, xh2, xh2a
PP: xh1

1 Volume 1 account prepared by S. Cannings.

Grasshopper Sparrow
(Ammodramus savannarum)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Broad ecosystem units

BS, SS

Elevation

Breeding activity in British Columbia occurs mainly between 300 and 500 m, although nests have been found between 1000 and 1160 m (Campbell et al. 2001).

Life History

This species has not been studied in British Columbia, therefore life history characteristics are inferred from studies of *A. savannarum perpallidus* in North America or other subspecies.

Diet and foraging behaviour

The diet of breeding Grasshopper Sparrows in Nebraska consisted of 33% seeds and 67% arthropods, although nestlings were fed entirely on arthropods (Kaspari and Joern 1993). Adults in Nebraska selected acridid grasshoppers (Orthoptera) and adult Coleoptera above all else, followed by Hemiptera species, although Homoptera species were more widely available (Kaspari and Joern 1993). In other locations including Oklahoma and South Dakota, grasshoppers (Orthoptera species) and Lepidopteran larvae made up a large proportion of the adult diet, although seeds still accounted for 14–39% of breeding season diet (Wiens 1973; Vickery 1996). In Wisconsin, nestlings were fed primarily Lepidoptera larvae, with other items including Odonata, Orthoptera, Hemiptera, Diptera larvae, Arachnida, and Oligochaete (Wiens 1969).

Concurrent measures of prey availability revealed that adult Grasshopper Sparrows are not opportunistic foragers as suggested by Wiens and Rotenberry (1979) but rather select prey based on size and profitability (Kaspari and Joern 1993). They avoid small prey, and prey with high chitin ratios, and will strip insects of their chitinous exoskeletons to maximize food value for effort (Kaspari and Joern 1993).

Reproduction

Only five clutches have been recorded in British Columbia, and dates for these ranges from 2 June to 11 July (Campbell et al. 2001). Three nests had four eggs, one nest had six eggs, and one nest had one egg (Campbell et al. 2001). Information about reproduction is inferred from studies in other areas.

Males begin territory establishment upon arrival at breeding grounds (Smith 1968). Pairs form immediately after arrival of females at breeding ground, usually 3–5 days after males. Nest building may be initiated immediately, and the female alone builds the nest over 2–3 days. Nests are typically 11–14 cm in diameter, and 5–7 cm in height. Grasshopper Sparrows commonly produce two or more broods in a year, when conditions are favourable. Nests are not reused in subsequent nesting attempts. Clutch size varies from three to six, with second clutches generally smaller, often with two eggs.

The female alone incubates the clutch for 11–13 days (Smith 1968). If a female is flushed while incubating, she is likely to feign injury to distract predators (Smith 1963). There is a record of a Grasshopper Sparrow dumping two eggs into a Savannah Sparrow nest (Wiens 1971). The eggs were incubated and hatched although the nestlings were subsequently predated (Wiens 1971).

Both males and females feed nestlings (Vickery 1996). Non-parental attendants helped to feed nestlings at 4 of 23 nests in Nebraska between 1981 and 1984, although it did not affect nestling survival (Kaspari and O'Leary 1988). This was most likely misdirected parental care and not kin-based altruism since there was no evidence of site fidelity (Kaspari and O'Leary 1988).

Juveniles are well feathered by 9 days when they leave the nest, and plumage is complete by 10–12 days (Smith 1968). Nestlings in Nebraska departed nests at 6–8 days (Kaspari and O'Leary 1988). Both sexes give approximately 4–19 days of post-fledging parental care before females initiate nest construction for the second clutch. Fledglings disperse immediately from the vicinity of the nest, and young of first brood are dispersed by the time second brood is being fed (Vickery 1996). Grasshopper Sparrows breed the first spring after hatching, and presumably every year after (Vickery 1996). Nesting success rates in Missouri Conservation Reserve Program (CRP) fields were 32–63% (McCoy et al. 1999), 30% in Iowa CRP fields (Patterson and Best 1996), and 20% in Minnesota (Johnson and Temple 1990).

Grasshopper Sparrows are thought to experience a low level of brood parasitism by Brown-headed Cowbirds (*Molothrus ater*) (Smith 1968), although parasitism levels vary throughout their range (2–50%) (Vickery 1996). One of the five nests recorded in British Columbia had a cowbird egg (Cannings et al. 1987). However, in Ontario, only 8% of nests were parasitized by cowbirds ($n = 74$) (Peck and James 1987). It is possible that the structure and placement of nests keeps them well hidden from cowbirds (Burger et al. 1994).

Site fidelity

Return rates of Grasshopper Sparrows to former breeding sites differ markedly between populations and probably between years (Vickery 1996). There is no evidence of site fidelity of this species in Nebraska (Kaspari and O'Leary 1988), although a 20% return rate was recorded in California (Collier 1994, cited by Vickery 1996). Site fidelity of migrants may be more evident in the eastern United States, including a 50% return rate of birds in Connecticut ($n = 10$) and 35% at Kennebunk Maine ($n = 42$), although site fidelity was not recorded at other sites in Maine (Vickery 1996).

Banding studies show an average longevity of 2.9 years in Florida with an annual survival rate of 0.6 (Delany et al. 1993 in Vickery 1996), and a longevity record of 6.6 years (Dean et al. 1998). Longevity data for migrant subspecies are unreliable due to low return rates, and survival rates have not been determined, but the longevity record for a migrant Grasshopper Sparrow is 3 years and 1 month, in Nebraska (Klimkiewicz and Futcher 1987).

Home range

There are no data on breeding territory size or home ranges within British Columbia. *Ammodramus savannarum perpallidus* territories in California were unusually small, averaging 0.37 ± 0.16 ha (Collier 1994, cited by Vickery 1996). Elsewhere in the United States, Grasshopper Sparrow territory size ranges from 0.66 to 1.4 ha (Vickery 1996), with the Florida subspecies (*A. savannarum floridanus*) averaging 1.8 ha/territory (Delany et al. 1995). Breeding densities range between 0.55 and 1.3 territories/ha (Vickery 1996) throughout the midwest and eastern United States, with lower densities reported in Florida: 0.037–0.061 territories/ha (Delany et al. 1995).

Grasshopper Sparrows tend to be semi-colonial, breeding in small groups of 3–12 pairs, while nearby apparently suitable habitat is left unoccupied (Smith 1968). In grassland/shrub-steppe habitat of the lower south Okanagan and Similkameen valleys in 1998, this species was present at five separate locations in groups of 2–5 singing males (Paczek, unpubl. data). Between 8 June and 30 July, 2001, this species was detected during 34 ten-minute point count station surveys in five separate locations, including White Lake Basin, Willowbrook, Haynes Lease Ecological Reserve, Kilpoola Provincial Park (Order In Council), and Chopaka East Provincial Park (Order In Council) (A.M. Bezener, pers. comm.). Small groups of singing males have been recorded elsewhere in British Columbia (Cannings 1995).

Movements and dispersal

The Grasshopper Sparrow arrives in British Columbia as early as 1 May, with build up of numbers occurring by mid-May (Campbell et al. 2001). Autumn departure probably occurs from September through the first half of October, with the latest sighting in the Okanagan recorded at 19 October (Cannings et al. 1987).

Habitat

Structural stage

2: herb
3a: low shrub

Important habitats and habitat features

Grasshopper Sparrows exhibit variable responses to habitats throughout its range. *Ammodramus savannarum pratensis* is most commonly found on cultivated grasslands, while *A. savannarum perpallidus* prefers native prairie habitats (Smith 1968).

Nesting

Grass cover is important for concealing nests (Vickery 1996). Grasshopper Sparrow nests are extremely difficult to find, usually hidden at the base of clumps of grass, clover, dead vegetation, alfalfa, or other cover (Smith 1968). In Florida, *A. savannarum floridanus* often places nests beneath dwarfed live oak (*Quercus minima*) instead of grass clumps (Delany and Linda 1998). Nests are sunk into depressions, with the rim flush with the ground. Nests are made of dried grass and lined with fine materials including grasses, sedges, and sometimes hair (Vickery 1996). The top is usually arched or domed at the back, giving it an oven-like appearance (Smith 1968).

Grasshopper Sparrows typically select moderately open grasslands and prairies with patchy bare ground (Vickery 1996). Grasshopper Sparrows in Wisconsin occurred at the highest densities in habitats with relatively short vegetation (Ribic and Sample 2001). In eastern Washington, Grasshopper Sparrows were positively associated with perennial grasses, which are indicative of native grassland (Vander Haegan et al. 2000). Soil type (loamy, shallow, or sandy) and range condition (good, fair, or poor) had a significant interaction when used to describe abundance of this species. Grasshopper Sparrows were most abundant in sites that had loamy soil with fair range, or shallow soil with poor range (Vander Haegan et al. 2000).

In British Columbia, Grasshopper Sparrows are generally found in bluebunch wheatgrass habitats, including bunchgrass-sagebrush associations (Cannings 1995). In a survey of sagebrush (*Artemisia tridentata*) habitat in the south Okanagan–lower Similkameen valleys, Grasshopper Sparrows occurred in sites with relatively sparse sagebrush cover, and an abundance of cheatgrass and pasture sage (*Artemisia frigida*) (Paczek 2001). Needle-and-thread grass (*Stipa comata*) was the dominant perennial grass. Grasshopper Sparrows elsewhere have been noted as avoiding dense shrub cover (Vickery 1996; Madden et al. 1999), although they were not negatively associated with shrub cover in Washington (Vander Haegan et al. 2000). Grasshopper Sparrows in North Dakota have been described as a species that occurs mainly in areas that are in transition between shrub-steppe and grassland (Kantrud and Kologiski 1983). In Arizona, the Grasshopper Sparrow is clearly a grassland species, but scattered shrubs are an important component of its habitat (Bock and Bock 1992).

The positive association of Grasshopper Sparrow with cheatgrass, a weedy annual grass, and pasture sage indicates that this species tolerates some level of disturbance, and habitat selection may not be affected by invasion of exotic species (Paczek 2001). Grasshopper Sparrows may respond more to plant structure than floristics, as they were more abundant in areas with abundant Eurasian weeds, relative to native plants in Manitoba, Illinois, and Colorado (Wilson and Belcher 1989; Haire et al. 2000; Walk and Warner 2000). Presence of weeds could indicate habitats that are rich in prey. For example, in Arizona, grasshoppers (Orthoptera) prefer rangelands dominated by weedy herbs rather than well-grassed ranges (Nerney 1958); in Oklahoma, Orthoptera, particularly acridids, increased in moderate to heavily grazed grassland (Smith 1940). Grasshopper Sparrow abundance was equal between lightly grazed introduced crested wheatgrass (*Agropyron cristatum*) stands and lightly grazed native mixed-grass prairie in Saskatchewan (Sutter and Brigham 1998). In British Columbia, this species is found in crested wheatgrass areas at the West Bench site, but not in crested wheatgrass areas on Mount Middleton (Cannings 1995). In the lower south Okanagan and Similkameen valleys, Grasshopper Sparrows had a slight negative correlation with crested wheatgrass (Paczek, unpubl. data).

Song perches in general are important for Grasshopper Sparrows, which sing most often from fixed perches such as shrubs, flower stems, and fence posts, and occasionally from the ground, usually in the periphery of their territories (Vickery 1996).

Foraging

Grasshopper Sparrows forage exclusively on the ground, and require some amount of bare ground for foraging (Whitmore 1981; Vickery 1996).

Wintering

Little is known about the winter habitat requirements of this species. *Ammodramus savannarum pratensis* has been recorded as wintering in grass-dominated fields and native prairie (Vickery 1996).

Conservation and Management

Status

The Grasshopper Sparrow is on the provincial *Red List* in British Columbia. Its status in Canada has not been evaluated (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	WA	ID	MT	Canada	Global
S2B	S4B	S3B, S2N	S3B, S2N	S4B, S2N	N4B	G5

Trends

Population trends

Breeding Bird Survey (BBS) data for Grasshopper Sparrows across North America have indicated a significant, consistent decline in population from 1966 to 2000 at about -3.71%/yr (Peterjohn and Sauer 1999; Sauer et al. 2001). In a regional comparison of BBS surveys, this species has one of the greatest estimated rates of decline among grassland birds of the midwestern United States, at -5.5%/yr (Herkert 1995). Grasshopper Sparrows occur only on 4 of 73 BBS routes in the British Columbia interior (Campbell et al. 2001), but in Canada, this species has a rate of decline of -4.83/yr between 1966 and 2000, with a rate of -6.33%/yr between 1980 and 2000 (Sauer et al. 2001).

While trends in British Columbia are difficult to establish, the Grasshopper Sparrow appears to have become regular in the province in recent years, despite habitat loss and fragmentation (Campbell et al. 2001). Since 1958, this species has been recorded in British Columbia nearly every year. Since 1898, when the species was first recorded in British Columbia, there have been 66 years where Grasshopper Sparrows were not recorded, with periods of absence being as long as 19 years (Campbell et al. 2001). The British Columbian population appears to be stable but small, with an estimated 50 pairs or less (Cannings 1995). In Washington, this species appears to be declining as a result of overgrazing and conversion of native grassland to agriculture (Smith et al. 1997, cited by Campbell et al. 2001).

Habitat trends

Much of Grasshopper Sparrow habitat in British Columbia has already been lost or altered by conversion to agricultural and residential developments (Cannings 1995). Currently, only 5% (724 ha) of potential habitat occurs on lands managed with conservation objectives. An additional 23% is Crown land. The majority of potential habitat is located on private land (40%) or Indian reserves (32%) (MELP 1998).

Over half of the native shrub-steppe in Washington has been converted to agricultural lands (Vander Haegen et al. 2000).

Threats

Population threats

There has been little documentation on predation in British Columbia. It is possible that Grasshopper Sparrow nests are less vulnerable to predation due to their closed roof construction (Burger et al. 1994).

In a study of *A. savannarum pratensis* in Iowa, 89% of predation was attributed to mammals including Red Fox (*Vulpes vulpes*), Raccoon (*Procyon lotor*), and Striped Skunk (*Mephitis mephitis*) (Patterson and Best 1996). Other recorded predators include hawks, Loggerhead Shrikes (*Lanius ludovicianus*), weasels (*Mustela* spp.), ground squirrels (*Spermophilus* spp.), cats (*Felis catus*), and snakes (Smith 1968; Vickery 1996). As nests are well concealed, and the birds stay close to the grass, predation by raptors is probably rare (Smith 1968). Grasshopper Sparrows are commonly impaled by Loggerhead Shrikes in Oklahoma (Vickery 1996) although Loggerhead Shrikes are infrequent visitors to the Okanagan (Cannings et al. 1987). Information is lacking on the impact of predators on survival, but high nest failure rates (80%) have been recorded in agricultural land in Iowa due to nest predation (Vickery 1996).

Trampling of nests by cattle is a concern (Campbell et al. 2001), and in areas where Grasshopper Sparrows use cultivated fields, nests may be crushed during mowing (Smith 1968). Application of insecticides in Grasshopper Sparrow territories would adversely affect this species because the chemicals both reduce food supply and are highly toxic to birds (Cannings 1995). Herbicide spraying on Grasshopper Sparrow habitat may pose other potential threats.

Habitat threats

The largest threat to Grasshopper Sparrow habitat is probably the continued loss and fragmentation of grasslands due to development. Across the United States and Canada, declines in native prairie since European settlement vary, but are as high as 99.9% in Manitoba and some mid-western states (Samson and Knopf 1994). Over 90% of the land in the Okanagan and lower Similkameen valleys has already been altered from its original state (Redpath 1990, cited by Cannings 1995). Two sites at the northern end of the Okanagan Valley where this species has occurred regularly; Mount Middleton and Goose Lake, are now adjoined by residential development and may soon become unsuitable habitat (Campbell et al. 2001). Grasshopper Sparrows are known to be area sensitive in much of their range, preferring large tracts of grassland habitat (Herkert 1994; Vickery et al. 1994; Haire et al. 2000; Johnson and Igl 2001). Grasshopper Sparrows in the lower south Okanagan and Similkameen valleys occurred in areas surrounded by shrub-steppe, and were generally absent from areas with agriculture or forest within a 500 m radius (Paczek 2001). Occupation of sites by this species was highly correlated with the amount of shrub-steppe within a 2 km radius (Paczek 2001). Development of land therefore not only results in habitat loss, but fragmentation may cause the remaining habitat to become less suitable.

This species has shown to respond positively to fire throughout its range. Short-term studies typically show an immediate negative response to fire, with birds preferring areas >1 year after burning (Vickery 1996). In a long-term study of effects of fire in North Dakota, Grasshopper Sparrows were absent from native prairie that had been unburned for >15 years (Madden et al. 1999). This species preferred a short burn period of 2–4 years (Madden et al. 1999), and in Florida, some areas with Grasshopper Sparrows are burned in winter at 2–3 year intervals for management purposes (Delany et al. 1985). Although these burn intervals approximate the natural pre-settlement burn cycle for these particular areas, the grasslands and shrub-steppe of British Columbia likely have a different pre-settlement burn interval. The effect of fire in British Columbia is unknown, although burning would probably benefit this species by reducing shrub cover (Madden et al. 1999). Unfortunately, invasion by cheatgrass in the lower south Okanagan and Similkameen valleys may have already changed the fuel properties of some areas, making restoration to native species difficult (Knick and Rotenberry 2000). Restoration burns in areas that have had fire suppression are often hotter (Madden et al. 1999), so the further spread of cheatgrass is a management concern.

Mowing hayfields during breeding season is a threat to habitat in the eastern range of this species (Smith 1968; Frawley and Best 1991). However, this practice does not generally take place in the native grasslands used by the western race in British Columbia (Cannings 1995).

Much of the Grasshopper Sparrow habitat in British Columbia is subject to grazing, and specific effects in this province are unclear, as the open areas where this species occurs have often been disturbed by grazing (Paczek 2001). Effects of grazing on this species vary in the literature. Generally, light to moderate grazing is beneficial in lusher habitats, and heavy grazing in shorter, drier habitats is detrimental (Saab et al. 1995). Grasshopper Sparrows in Illinois responded positively to light, late season grazing (Walk and Warner 2000), while in Arizona this species occurred only on ungrazed sites (Bock and Webb 1984). Overgrazing can lead to increased sagebrush density and reduce suitable land for Grasshopper Sparrows (Campbell et al. 2001). However, grazing is also correlated with increased grasshopper abundance (Smith 1940, Nerney 1958).

Legal Protection and Habitat Conservation

The Grasshopper Sparrow, its nests, and its eggs are protected in Canada by the *Migratory Birds Convention Act*. In British Columbia, the same are protected from direct persecution by the provincial *Wildlife Act*.

The Nature Trust of British Columbia and the province currently protect Grasshopper Sparrow habitat at White Lake Basin, Vaseux-Bighorn National Wildlife Area, and Haynes Lease ecological reserve. New provincial parks proposed at White Lake Basin (White Lake Provincial Park, Order In Council) and International Grasslands (Chopaka East, Chopaka West, and Kilpoola Provincial Parks, Orders In Council) through the Okanagan-Shuswap Land and Resource Management plan would also include important Grasshopper Sparrow habitat.

Under the results based code, range use plans may be used to meet the requirements of this species. In some cases, current grazing practices may be adequate to maintain habitats for this species and therefore it may not be necessary to establish a WHA. This assessment must be made case by case.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

❖ Maintain large areas (>100 ha) of suitable shrub-steppe habitat within the range of the species.

❖ Maintain and maximize connectivity of suitable habitats.

❖ Where prescribed burning is practised as a habitat enhancement strategy, consider rotational burning that creates a mosaic of burned and unburned areas. Madden et al. (1999) recommend burning 20–30% in rotation so that birds always have access to unburned land. This mosaic approach can be used to encompass habitat requirements of other grassland species. The same approach could be applied to livestock grazing.

Wildlife habitat area

Goal

Provide suitable nesting habitat as described previously under "Important habitats and habitat features."

Feature

Establish WHAs at locations where two or more singing males have been recorded regularly (i.e., consecutively over several years).

Size

A minimum of 10–15 ha to allow occupation by multiple pairs and accommodate semi-colonial breeding territories.

Design

Include open native grassland and shrub-steppe habitats with sparse shrub cover (<15%) and moderate amounts of bare ground and grass cover. Ideally, WHAs should be surrounded by native grassland habitat and preferably located 500 m or more from forest, development or agricultural edges.

General wildlife measures

Goals

1. Prevent destruction and abandonment of nests by minimizing disturbance during critical breeding times.
2. Maintain dense clumps of grass used for nesting and cover.
3. Promote natural disturbance regimes such as fire to control shrub density and enhance grass growth.

Measures

Access

- Do not construct roads, trails, or other access routes.

Pesticides

- Do not use pesticides.

Range

- Do not concentrate livestock use between 1 May and 1 August.
- Plan livestock grazing to maintain desired structure of plant community, desired stubble height, and browse utilization. If there is no other practicable option to avoid incompatible livestock grazing, the statutory decision maker may recommend fencing.

Additional Management Considerations

Consider prescribed burning to decrease shrub cover, and promotes the growth of grasses (Madden et al. 1999). Prescribed burning in late autumn or winter, or other methods of shrub control could be used to maintain open grasslands with relatively sparse sagebrush cover.

Maintenance of large tracts of grassland appears to be important for this species (Vickery 1996), although the minimum patch size for Grasshopper Sparrows varies among studies and regions. In Nebraska where this species is common, a patch area of 5 ha (square) or 3.9 ha (circular) was recommended (Helzer and Jelinski 1999). This is considerably lower than a minimum patch size of 30 ha recommended by Herkert (1994) and 100 ha in Maine (Vickery et al. 1994). Vickery et al. (1994) suggested that the large area requirement they estimated for Grasshopper Sparrow could be attributed to increased habitat selectivity because of low population numbers of this species. Patch shape had more influence on Grasshopper Sparrow presence than did patch area in a habitat fragmentation study in Nebraska (Helzer and Jelinski 1999). Grasshopper Sparrows were among several species that were negatively correlated with perimeter-area ratio, which reflects both the area and shape of a patch (Helzer and Jelinski 1999).

Since much of the suitable Grasshopper Sparrow habitat in the province has already been lost or degraded (Cannings 1995), efforts should be made to reduce further habitat fragmentation and loss, and restore degraded habitat where possible.

Information Needs

1. Basic life history and habitat information in British Columbia (i.e., predator information, site fidelity, foraging habitat requirements, preferred food sources, territory establishment and maintenance, breeding success).
2. Reproductive success in native versus weedy habitats to determine success in weedy habitats.
3. Response of this species to grazing and prescription or other burns in British Columbia. Regular burns enhance Grasshopper Sparrow habitat elsewhere in North America (Delany et al. 1985; Madden et al. 1999).

Cross References

"Great Basin" Gopher Snake, Long-billed Curlew, Racer

Management strategies for other red-listed songbird species—Sagebrush Brewer's Sparrow and Sage Thrasher—may conflict with Grasshopper Sparrow needs. Sagebrush Brewer's Sparrow and Sage Thrasher require abundant sagebrush for nesting, unlike Grasshopper Sparrows that occur in sparse shrub cover.

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"Sagebrush" Brewer's Sparrow

Spizella breweri breweri

Original[1] prepared by Martin Gebauer

Species Information

Taxonomy

The Brewer's Sparrow is in the genus *Spizella*, although its relationship within the genus remains uncertain (Rotenberry et al. 1999). Five other sparrow species in North America are included in the genus: American Tree Sparrow (*S. arborea*), Field Sparrow (*S. pusilla*), Chipping Sparrow (*S. passerina*), Clay-colored Sparrow (*S. pallida*), and Black-chinned Sparrow (*S. atrogularis*) (NGS 1999).

Two subspecies of Brewer's Sparrow are currently recognized, *S. breweri breweri* (Sagebrush Brewer's Sparrow) and *S. breweri taverneri* (Timberline Brewer's Sparrow). *Spizella breweri breweri* breeds in lowland and upland sagebrush habitats of British Columbia primarily within the Great Basin region in the south Okanagan and Similkameen valleys, but may occur as far north as the Chilcotin River. In British Columbia, *S. breweri taverneri* is reported to breed in subalpine shrubs, and does not apparently breed south of the Canada–U.S. border (Godfrey 1986; Cannings 1998; Rotenberry et al. 1999). Some authors consider these two subspecies to be separate species (Sibley and Monroe 1990; Klicka et al. 1999). Unless otherwise noted, this account refers to the *breweri* subspecies.

Description

The Brewer's Sparrow is one of the most plainly marked sparrows. It bears a strong resemblance to the Clay-colored Sparrow, although the facial markings are much less distinct. The Brewer's Sparrow can be further distinguished by a brown crown with fine black streaks and the absence of the clear pale central strip of the Clay-colored Sparrow. The Brewer's Sparrow also features a whitish eye ring and greyish-white eyebrow. The ear patch is pale brown with darker borders and the bill is dusky above and slightly paler below. Upperparts are buffy brown and streaked with black, and the rump is buffy brown and may be lightly streaked. The tail is dark brown and narrowly edged with grey and lacks the whiter outer tail coverts of the Vesper Sparrow (*Pooecetes gramineus*). Underparts are dull white with the breast and sides lightly washed with greyish buff (Godfrey 1986; NGS 1999).

Distribution

Global

The Brewer's Sparrow is restricted to North America, breeding from the southern Interior of British Columbia, southeastern Alberta and southwestern Saskatchewan, south through Washington, Oregon, and California, east of the Cascades, throughout most of Montana, Nevada, Utah, Wyoming, and northern Arizona and east to include portions of Colorado, North Dakota, South Dakota, and Nebraska. Sporadic breeding has been reported in Kansas, Oklahoma, and the Texas Panhandle (Rotenberry et al. 1999).

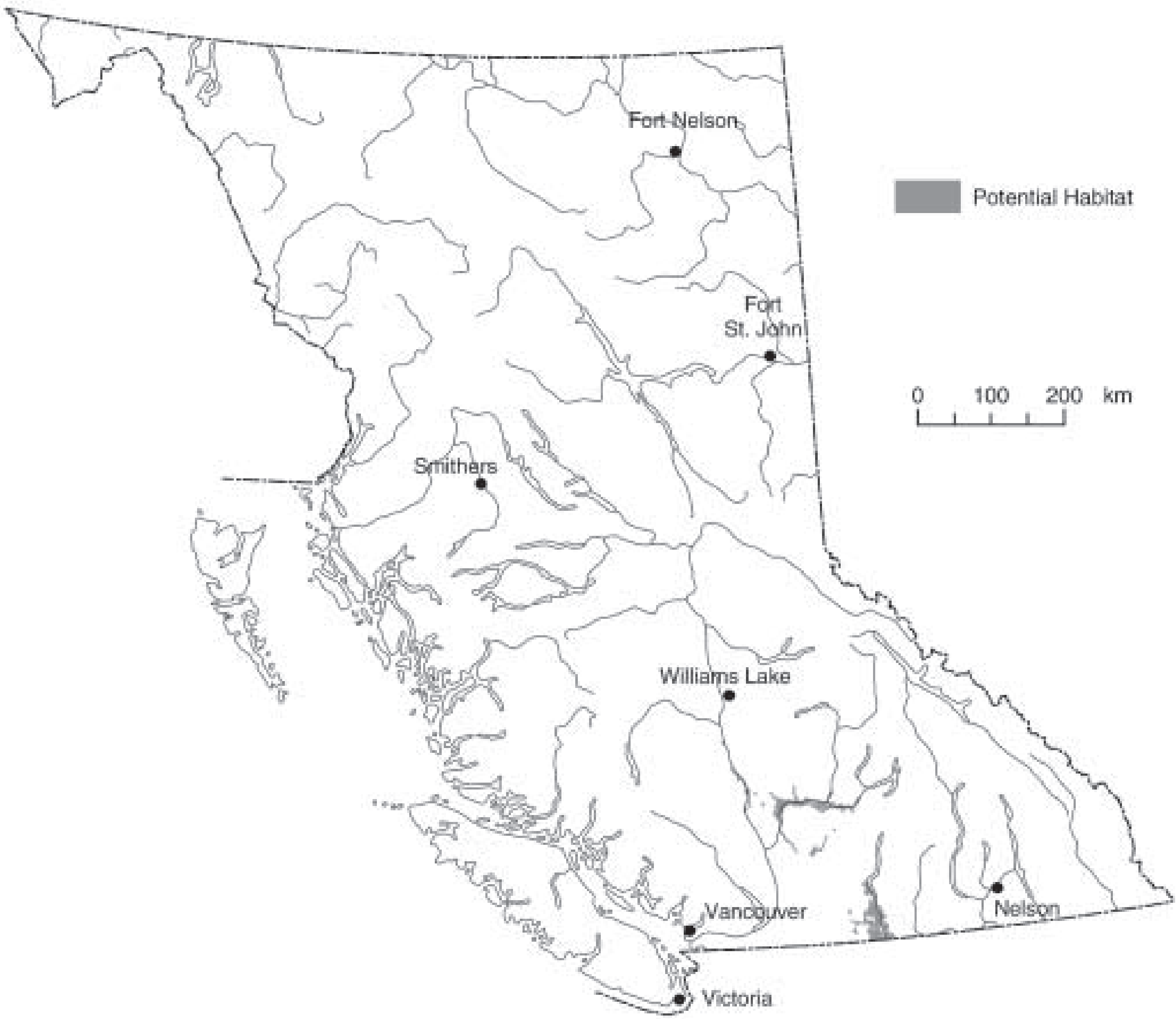
The Sagebrush Brewer's Sparrow winters from southeastern California to western Texas south throughout Baja California and Sonora, the Pacific Lowlands of northern and central Mexico, and the highlands of west-central Mexico to Guanajuato (Howell and Webb 1995; Rotenberry et al. 1999; Campbell et al. 2001). There is currently no information on how the two subspecies are distributed on wintering grounds (Rotenberry et al. 1999).

British Columbia

The Sagebrush Brewer's Sparrow breeds in the extreme southern portions of the southern Interior west of the Okanagan River, from the Marron Valley

1 Volume 1 account prepared by L. Hartman.

Brewer's Sparrow - subspecies *breweri*
(Spizella breweri breweri)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

south to Kilpoola Lake near the International Boundary (Campbell et al. 2001). Brewer's Sparrows have also been reported and may occasionally breed in several other interior locations including Vernon, Kamloops, Ashcroft, the Chilcotin River, and Riske Creek (Campbell et al. 2001).

Forest region and districts

Southern Interior: 100 Mile House (possible), Central Cariboo, Kamloops, Okanagan Shuswap

Ecoprovinces and ecosections

CEI: FRB (possibly)

SIM: EKT

SOI: OKR, SOB, NOB suspected in THB and NTU

Biogeoclimatic units

BG: xh1, suspected in xh2, possible in xh3, xw, xw1,

IDF: dk1, dk1a, dm1, dm2, xh1, xh1a, xh2, xh2a

PP: dh2, xh1, xh1a, xh2, xh2a

Broad ecosystem units

DP, PP, SS

Elevation

In British Columbia, the Brewer's Sparrow has been observed nesting at elevations ranging primarily from 340 to 750 m (Campbell et al. 2001). Breeding behaviour has been observed at 1000 m (Mahony 2003; Paczek 2001), and Cannings et al. (1987) have reported sightings up to 1860 m on Mount Kobau, where sagebrush extends to join stands of subalpine fir (*Abies lasiocarpa*). Mahony (pers. comm.) found two upper elevation sites of the Sagebrush Brewer's Sparrow on a high elevation plateau near Blind Creek, on the north side of Mount Kobau.

Life History

Diet and foraging behaviour

Diet consists of seeds, spiders, and insects, especially caterpillars (see Rotenberry et al. 1999 and Stephens 1985 for details on taxa in adult diet), which are gleaned from open ground between and beneath sagebrush plants (MELP 1998) and from shrub foliage (Dobkin 1992). Brewer's Sparrow nestlings in Idaho had a diet consisting of a wide range of arthropod orders including Lepidoptera, Araneae, Hemiptera, and Homoptera (Petersen and Best 1986). During the breeding season, Brewer's Sparrow are primarily insectivorous.

During the breeding season, Brewer's Sparrows forage throughout the day, although mornings and late evening before sunset tend to be more active times. Seeds are picked up from the ground and only occasionally are birds observed gleaning seeds directly from plants (Rotenberry et al. 1999). Birds will occasionally fly up and catch insects on the wing (Rotenberry et al. 1999).

Reproduction

Dates for 251 clutches in British Columbia ranged from 12 May to 18 July, with 52% recorded between 4 June and 30 June (Campbell et al. 2001). Dates of clutch initiation in a 4-year study in the south Okanagan ranged from 30 April to 21 July (Mahony 2003). Average size of 119 clutches ranged from one to five eggs with 79% having three or four eggs (Campbell et al. 2001). Averages clutches of three to four eggs have also been reported by Paine (1968), Reynolds (1981), and Rotenberry and Weins (1989). Incubation period ranges from 10 to 13 days but is typically 11 days (Ehrlich et al. 1988; Rotenberry et al. 1999). Dates for 157 broods in British Columbia ranged from 26 May to 01 August (Campbell et al. 2001). Broods observed by Mahony (2003) in the south Okanagan ranged between 13 May and 2 August. Sizes of 88 broods ranged from one to four young with 80% having three or four young (Campbell et al. 2001). Young fledge from 6 to 9 days (Ehrlich et al. 1988; Rotenberry et al. 1999; Mahony et al. 2002). Pairs will frequently double-brood (Rotenberry et al. 1999). In British Columbia, females regularly made multiple nesting attempts with 17% (n =132) females successfully fledging two broods in a season, and two females fledging three broods (Mahony et al. 2002). In Washington, 5% of females fledged two broods per season (Mahony et al. 2002).

Low levels of Brown-headed Cowbird (*Molothrus ater*) parasitism has been observed in Brewer's

Sparrows nesting in British Columbia (i.e., 6 of 154 nests) (Campbell et al. 2001), and in other areas throughout their range (Rich 1978; Friedmann and Kiff 1985; Rotenberry and Weins 1989; Vander Haegen and Walker 1999, cited by Campbell et al. 2001). In a recent study in the south Okanagan, Mahony (2003) found that only 3% of 664 nests (~20) were parasitized by cowbirds. In Alberta, a relatively high level of cowbird parasitism (i.e., 13 of 25 nests) was reported (Biermann et al. 1987).

Most parasitized Brewer's Sparrow nests are abandoned by adults (Friedmann and Kiff 1985; Biermann et al. 1987). Of 20 parasitized nests found between 1997 and 2000 in the south Okanagan, most were abandoned or the cowbird eggs failed to hatch, and only one cowbird chick hatched and fledged (Mahony 2003).

Site fidelity

In southeastern Idaho, about 25% of colour-banded adult birds returned to nesting habitat used the previous year (Petersen and Best 1987). Adult annual survival rates in the south Okanagan varied with year but averaged 47% over 3 years (Mahony 2003). Only 4.2% of 495 nestlings banded in the south Okanagan, were resighted in the region. Of these, only 19% moved from natal sites to other areas within the Okanagan to breed (Mahony 2003). Of about 400 nestlings banded in the Great Basin area of the United States during a 7-year period, none returned to breed near their natal site (Rotenberry et al. 1999).

Home range

In the south Okanagan, territories are approximately 0.4–0.5 ha (Cannings et al. 1987). Mean breeding territory size of Sagebrush Brewer's Sparrows in Oregon ranged from 0.55 to 1.25 ha (Weins et al. 1985) and in Idaho, mean territory size was 0.52 ha. Brewer's Sparrows are often semi-colonial breeding in loose aggregations of 2–21 pairs and occupying areas of 6–225 ha (Harvey 1992).

Densities of Sagebrush Brewer's Sparrows in the south Okanagan reported by Harvey (1992) ranged from 1.83 males/100 ha along Nighthawk Road, to 5.86 males/100 ha at White Lake, to 9.05 males/100 ha at Kilpoola Lake West area. Breeding densities in Nevada ranged from 1.50 to 1.68 individuals/ha between 1981 and 1983 (Medin 1992), whereas breeding densities in Washington ranged from means of 0.51 to 0.85 individuals/ha between 1988 and 1990 (Dobler et al. 1996).

Recent data by Mahony and Paczek (unpubl. data) from the south Okanagan suggest that at least 2.6 times as many pairs may be present in an area than the number of singing males recorded on bird surveys indicates.

Movements and dispersal

The Sagebrush Brewer's Sparrow arrives in the south Okanagan as early as the third week of April (19 April) with numbers increasing to the last week of May (Cannings et al. 1987; Campbell et al. 2001). No discernible autumn movement has been noted in the south Okanagan, but reports of birds drops sharply by mid-July as birds stop singing, and few birds remain after the end of August, most likely young of the year (latest record on 22 September) (Campbell et al. 2001). A recent study of post-fledging survival and dispersal showed that once young Sagebrush Brewer's Sparrows and adults had finished breeding, they moved from sagebrush-dominated breeding areas to aspen gullies and areas with large non-sage shrubs in the post-breeding but pre-departure stage in July and August (Yu 2001). A survey by Hobbs (2001) indicated a strong relationship between the occurrence of breeding sites in proximity to aspen stands. All six sites at which breeding behaviour was confirmed were located within 500 m of deciduous stands.

Habitat

Structural stage

Nesting

2: herb
3a: low shrub

Post-fledgling

4: pole/sapling (aspen stands)

Important habitats and habitat features

Nesting

The Sagebrush Brewer's Sparrow nests in sagebrush dominated shrub-steppe habitats (Castrale 1982; Cannings et al. 1987; Knick and Rotenberry 1995; Dobler et al. 1996; Sarell and McGuinness 1996; Paige and Ritter 1999). Despite the close relationship with sagebrush, high densities of shrubs (i.e., >50% foliar cover) may reduce suitability as breeding habitat (Dobler 1994; Harvey 1992; Sarell and McGuinness 1996). Dobler (1994) reported that sagebrush cover density was positively correlated to occurrence of Brewer's Sparrows up to approximately 20% cover. Although his data did not include results for >20%, he suggested that numbers would decline with increasing shrub density.

Harvey (1992) notes that Brewer's Sparrow prefer areas with no more than 10% bare ground. Dobler (1994) who found that Brewer's Sparrow numbers were negatively correlated with annual grass cover reported similar results. An interesting result by Paczek (2001) and Hobbs (2001) was that Sagebrush Brewer's Sparrows were more likely to be found in areas with large well-developed perennials such as parsnip-flowered buckwheat (*Eriogonum heracleoides*) and lupine (*Lupinus sericeus*) and at sites higher in elevation and moisture, and with more lush vegetation. Rotenberry and Weins (1989) found a direct correlation between winter precipitation and clutch size of Brewer's Sparrow, suggesting that birds are able to respond favourably to increased primary and secondary productivity.

Nests are compact cups of grasses, plant stems, and rootlets, lined with mammalian hair (e.g., horse and cow) and fine grasses (Godfrey 1986; Campbell et al. 2001). In the Okanagan, nests of Sagebrush Brewer's Sparrow are almost always built in sagebrush (92%), usually near the ground (mean height of 30 cm) (Cannings et al. 1987; Campbell et al. 2001). Mean nest heights of 25 nests measured by Sarell and McGuinness (1996) was 49 cm (range 12–104 cm). Nests have also been reported in common snowberry (*Symphoricarpos albus*), snowbrush (*Ceanothus velutinus*), and Douglas-fir (*Pseudotsuga menziesii*) (Sarell and McGuinness 1996).

Interestingly, at a site where a wildfire removed most of the sagebrush cover in 1994, Brewer's Sparrows nested in a variety of plants including giant wildrye (*Elymus cinereus*), common snowberry, lemonweed (*Lithospermum ruderale*), lupine, bluebunch wheatgrass (*Pseudoroegneria spicata*), common rabbitbrush (*Ericameria nauseosus)*, mustard species, diffuse knapweed (*Centaurea diffusa*), and rose species from 1997 to 2000 (Mahony 2003). However, by 2000, they had shifted back to nesting more in sagebrush as shrubs that germinated after the fire became large enough, demonstrating the placticity of this species that is adapted to a fire-dependent ecosystem.

Petersen and Best (1985) determined that Brewer's Sparrows preferred to nest in sagebrush shrubs that were entirely or mostly alive and were significantly taller and denser than surrounding shrubs. Knopf et al. (1990) observed that Brewer's Sparrows were positively correlated with shrub vigour presumably because healthy shrubs provide better protective cover and nest concealment. In British Columbia, mean nest shrub height ($n = 25$) was 110 cm and ranged between 64 and 170 cm (Sarell and McGuinness 1996). Mean height of nest shrubs in one Idaho study was 69 cm (range of 42–104 cm) (Petersen and Best 1985), and 66.9 cm in another Idaho Study (Rich 1980). In Oregon, average nest shrub height was 71 cm (range 50–107 cm) (Rotenberry et al. 1999). Rich (1978) found that Brewer's Sparrows built nests above the densest portion of a shrub whereas Sage Thrasher (*Oreoscoptes montanus*) and Sage Sparrow (*Amphispiza belli*) chose nest sites within the densest portions. In the Okanagan, Sagebrush Brewer's Sparrows placed nests in shrubs that were surrounded by a greater density of shrub cover than was randomly available at sites, presumably to hide their movements to and from nests from nest predators (Mahony 2003).

Brewer's Sparrows may avoid nesting close to trees to avoid predation by avian predators that perch in trees (e.g., corvids) (Welstead 2002). They may also select areas with low densities of avian predators (Welstead 2002).

Post-fledgling habitat

Yu (2001) found that adults and juveniles used aspen-dominated or shrub-dominated ravines more often than sagebrush habitats during the post-fledgling period even though these habitats represented only 15% of the available habitat.

Foraging

Sagebrush Brewer's Sparrows forage within sagebrush breeding habitat, although wetlands, mesic ravines, and aspen-dominated ravines may also be important insect foraging areas during the nesting season and especially in the post-breeding phase for both adults and independent young (Yu 2001). Weins et al. (1987) found that Brewer's Sparrows foraged primarily within shrubs (>75% of over 600 observations). Shrubs selected for foraging differ significantly from those randomly available. Larger, and more vigorous sagebrush are selected over smaller sagebrush and other shrubs such as rabbitbrush (*Chrysothamnus* spp.) (Rotenberry and Weins 1998). In the south Okanagan, sites with breeding Sagebrush Brewer's Sparrows had four times as many arthropods and two times as many species than sites not supporting breeding populations (P. Krannitz, unpubl. data). This was largely because of the predominance of herbaceous perennials at the sites of importance for Brewer's Sparrow, which tended to support more arthropods. Of particular note were larvae of the moth *Sparganothis tunicana* which were found on lupine plants (*Lupinus sericeus*) and were a favoured food for Brewer's Sparrow chicks (Mahony, pers. comm.)

Conservation and Management

Status

The Sagebrush Brewer's Sparrow is on the provincial *Red List* in British Columbia. Its status in Canada has not been evaluated (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	WA	ID	MT	Canada	Global
S2B	S4B	S4B, S2N	S4B, S2N	S4B, S2N	N?	G5T4

Trends

Population trends

Breeding Bird Survey results for the period 1966 to 1998 indicate a significant decline (-3.5%/yr) in Brewer's Sparrows across North America (Sauer et al. 1999). Significant trends in Canada were not noted, likely due to small sample sizes. Declines were noted in Wyoming (-2.25%), Idaho (-5.17%), and Montana (-2.85%) (Dobkin 1992; Sauer et al. 1999). Declines of -2.25%/yr were observed in western North America (i.e., British Columbia, Washington, Oregon, and California) but were not significant. Declines in the Columbia River Basin were 1.3% for the period 1968–1994 and 4.3% for the period 1984–1994 (Saab and Rich 1997). Declines are largely suspected to be due to loss of suitable sagebrush habitats resulting from range improvements (i.e., burning and clearing) and other land development activities (Rotenberry et al. 1999).

In British Columbia, Fraser et al. (1999) suggest that populations are probably declining slowly because of sagebrush habitat loss, but that populations appear to be stable where habitat is being maintained. An analysis of Breeding Bird Surveys in British Columbia for the period 1966 to 1998 did not reveal a significant trend (Sauer et al. 1999). However, sample sizes are likely too small to obtain significant results. Population size of Sagebrush Brewer's Sparrow in the south Okanagan was determined to be 826 birds (Harvey 1992) or an estimated 800–1000 adults (Sarell and McGuiness 1996). Using the 2.6 multiplication factor determined by Mahony and Paczek (unpubl. data), it is possible that as many as 2000 adults make up the south Okanagan population. Aggregations of up to half a dozen pairs are possible at some of the larger sites in the Thompson region but it remains to be determined if they are nesting successfully there.

The only site where comparisons of population trends over time can be inferred are at White Lake. Willing (1970) estimated between 20 and 30 pairs in 1968 and 1969, Cannings et al. (1987) found 20 males in 1978 and 22 in 1980, and Harvey (1992) reported 41 males in 1992. Although these data may suggest a stable population at White Lake, the survey methods differed so differences may be a result of survey methods. Data from 1998 to 2000 from a plot at White Lake indicate large yearly fluctuations in the breeding population from 51 breeding pairs in 1998 to 42 pairs in 1999 down to 27 pairs in 2000 (Mahony 2003).

Habitat trends

Approximately 3% of potentially suitable Sagebrush Brewer's Sparrow habitats in the south Okanagan is within conservation lands. About 38% is within provincial land (MELP 1998) but much of this is managed under grazing leases, which are not required to implement the recommendations of the *Forest and Range Practices Act*. Indian Reserves include 23% and private lands make up an additional 36% of suitable habitats in the south Okanagan (MELP 1998). The impacts of grazing, fire suppression, and other human activities on the availability of suitable Sagebrush Brewer's Sparrow habitats have not been thoroughly investigated.

In the south Okanagan, an unprecedented rate of urbanization and changes in agricultural practices have resulted in a decline in sagebrush habitats (Sarell and McGuinness 1996). In Washington, more than half of the native shrub-steppe ecosystem has been converted to agricultural lands (Dobler et al. 1996; Vander Haegen et al. 2000).

Threats

Population threats

Nest depredation is thought to be the most important cause of breeding failure. Rates of nest depredation in the Okanagan ranged from 14 to 65% of nests at four sites (Mahony 2003), within the range reported in many migratory songbird species (Martin 1992). Documented predators of eggs and nestlings include Gopher Snake (*Pituophis catenifer*) and Townsend's Ground Squirrel (*Spermophilus townsendii*) (Rotenberry et al. 1999) and Western Terrestrial Garter Snake (*Thamnophis elegans*) (N. Mahony, pers comm.). Other potential nest predators include Loggerhead Shrike (*Lanius ludovicinaus*), Western Rattlesnake (*Crotalus oreganus*), Common Raven (*Corvus corax*), American Crow (*Corvus brachyrhynchos*), Black-billed Magpie (*Pica pica*), Long-tailed Weasel (*Mustela frenata*), and Least Chipmunk (*Tamias minimus*) (Petersen and Best 1987, Rotenberry and Weins 1989). In Idaho, presence of shrikes significantly affected density and nesting success of Brewer's Sparrow (Woods 1994, cited by Rotenberry et al. 1999). American Kestrel (*Falco sparverius*), Prairie Falcon (*Falco mexicanus*), and Loggerhead Shrike have been reported as preying on adults (Rotenberry et al. 1999).

Habitat threats

Continued loss of sagebrush-steppe habitats is the primary threat to Sagebrush Brewer's Sparrow populations (Sarell and McGuinness 1996). Heavy grazing and clearing of sagebrush for urban and agricultural development are the greatest threats to sagebrush habitats (MELP 1998).

In Washington, more than half of the native shrub-steppe ecosystem has been converted to agricultural lands resulting in fragmentation and detrimental affects on numerous shrub-steppe species (Vander Haegen et al. 2000). The majority of habitat loss in the south Okanagan is due to an unprecedented rise in immigration to the area, and subsequent increase of human encroachment (Sarell and McGuinness 1996).

Fires may reduce sagebrush habitat for some time since sagebrush is slow to regenerate from fires (Castrale 1982). Sagebrush Brewer's Sparrow is immediately affected by the loss of shrubs and the effects on Brewer's Sparrow use of a burned area are particularly pronounced within the first few years (up to 4 years) following burning. N. Mahony (pers. comm.) suggests that fire may be an important component in creating high suitability habitat in areas that have not been grazed. Fire cycles of 7–20 years may make some areas temporarily unsuitable, but result in highly suitable habitat within 5–6 years in the absence of cattle grazing. In a recent burn in the south Okanagan, N. Mahony (pers. comm.) found that Sagebrush Brewer's Sparrow nested in other vegetation 3–5 years after burning, but were nesting again in small sagebrush shrubs that had germinated after the fire, 6 years later. Fire also burns off dead sagebrush and built-up organic material, resulting in more vigorous growth of grasses and herbs, with resulting increased insect prey of high importance to breeding Brewer's Sparrows.

Tree encroachment into grasslands due to fire suppression may also be negatively impacting Brewer's Sparrow by providing perches for nest predators and reducing amount of suitable habitat (Welstead 2002).

Heavy grazing pressure appears to negatively affect Sagebrush Brewer's Sparrow populations whereas light to moderate grazing does not appear to have a significant impact (Harvey 1992; Saab et al. 1995). Although some studies from other areas (Nevada, Idaho) have not reported differences in densities between grazed and ungrazed habitats (Reynolds and Trost 1980; Medin and Clary 1991), level of grazing is thought to be of concern in British Columbia. The impacts of livestock grazing include trampling/disturbance of nests, altering foraging habitat (understorey forbs), reducing aspen regrowth in post-fledgling habitats, as well as altering sagebrush stand density which may influence the establishment and defence of territories.

Intensive range management programs, such as burning, mowing, herbicide applications, and planting with crested wheatgrass (*Agropyron cristatum*), are thought to negatively impact sagebrush habitats and the birds using these areas (Reynolds and Trost 1981; Wiens and Rotenberry 1985; MELP 1988; Knick and Rotenberry 2000).

The spread of cheatgrass (*Bromus tectorum*) has had a negative impact on sagebrush habitats (Rotenberry et al. 1999). Cheatgrass, an annual species, tends to occur in large monocultures that are highly flammable, increasing the spread of fire and loss of sagebrush and other shrubs, and accelerates the spread of annuals such as cheatgrass (Paige and Ritter 1999, Knick and Rotenberry 2000).

Data concerning the effects of pesticides on Sagebrush Brewer's Sparrow are limited. Herbicides can destroy sagebrush habitat (Best 1972). Castrale (1982) found that 5 years after herbicide spraying, Brewer's Sparrows were virtually absent from a site where shrubs were completely killed. Best (1972) found that herbicide treatment of sagebrush resulted in a diet shift to greater proportion of seeds and a significant reduction in numbers of nesting birds in the season of spraying. Schroeder and Sturges (1975) found that Brewer's Sparrow use of a herbicided sagebrush stand 1–2 years after spraying was 67% and 99% lower, respectively, than use on an unsprayed stand, and no nests were observed in the sprayed area.

Insecticides may have an impact on food availability. In the United States, local declines of grassland birds have been potentially linked to grasshopper control programs using pesticides (Paige and Ritter 1999), although George et al. (1995) noted that pesticide treatments for grasshopper control had little effect on breeding bird communities in western rangelands. In shrub-steppe habitats in southern Idaho, Howe et al. (1996) found that malathion application had no observable direct effects, and only marginal indirect effects, through food-base reduction, on Brewer's Sparrow and Sage Thrasher nestling growth and survival.

Legal Protection and Habitat Conservation

The Brewer's Sparrow, its nests, and its eggs are protected in Canada and the United States by the *Migratory Birds Convention Act*. In British Columbia, the same are protected from direct persecution by the provincial *Wildlife Act*.

Protected areas in the south Okanagan include Nature Trust of British Columbia lands at White Lake and Kilpoola Lake. According to MELP (1998), only 3% (1496 ha) of potentially suitable Sagebrush Brewer's Sparrow habitat was designated as conservation lands. However, under the Okanagan–Shuswap Land and Resource Management Plan

(LRMP) process, 49 new protected areas were established in the south Okanagan. The Okanagan–Shuswap LRMP, approved in January 2001, covers approximately 2.5 million ha of which 122 963 ha of new protected areas were established in addition to the 71 643 ha of existing parks and ecological reserves (total of 194 606 ha or 7.9%). Some of the more important proposed protected areas for Brewer's Sparrows include White Lake Grasslands (3627 ha) and South Okanagan Grasslands (9700 ha).

Under the results based code, recommendations for managing riparian and grassland habitats may provide some protection of habitat for Sagebrush Brewer's Sparrow. Range use plans that consider the requirements of this species may address the needs of the species; however, for a species to be specifically addressed within these plans, they must be designated as Identified Wildlife. In some cases, current grazing practices may be adequate to maintain habitats for this species and therefore it may not be necessary to establish a WHA. This assessment must be made case by case.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- ❖ Maintain remaining late-seral sagebrush habitats and suitable dry shrub-steppe habitats.
- ❖ Maximize connectivity of suitable Sagebrush Brewer's Sparrow habitats (sagebrush habitats, aspen-dominated ravines).
- ❖ Encourage growth or restoration of a healthy native grassland and sagebrush communities.
- ❖ Within important Sagebrush Brewer's Sparrow breeding areas, as recommended by MWLAP:
    - Avoid thinning of dense stands of sagebrush (>50% foliar cover) except where recommend to improve nesting habitat.
    - Plan livestock grazing to avoid damage to sagebrush and sensitive herb and grass communities, and to maintain the desired sagebrush density (10–30% foliar cover).
    - Prevent forest encroachment.

Wildlife habitat area

Goal

Maintain suitable nesting for multiple pairs and post-fledgling habitat.

Feature

Establish WHAs over breeding aggregations of five or more pairs and high suitability shrub-steppe habitats (i.e., sagebrush sites ranging from structural stages 2–3a; age class 1).

Size

Typically between 5 to 50 ha of contiguous shrub-steppe habitats, or up to 225 ha of discontinuous habitat. Ultimately, size will depend on the area of suitable breeding habitat and post-fledgling habitat.

Design

The WHA should include sagebrush shrub-steppe habitats with a mosaic of habitat attributes including a low percentage of bare ground (i.e., 10–20%), moderate densities of shrubs (i.e., 10–30%), and high cover of flowering perennials. Aspen-dominated ravines and higher elevation aspen/saskatoon (*Amelanchier alnifolia*) shrubby areas within the vicinity (i.e., within 600 m) of breeding habitat should be included within WHAs.

General wildlife measures

Goals

1. Minimize disturbance and trampling by livestock.
2. Retain density and structure of sagebrush habitat.
3. Encourage forb-component in grasslands.
4. Promote development of native perennial herbs, grasses.
5. Maintain integrity of sagebrush and riparian communities.
6. Maintain aspen-dominated stands in a properly functioning condition.
7. Prevent tree encroachment.

Measures

Access

- Avoid road development.

Pesticides

- Do not use pesticides.

Range

- Limited thinning of dense (>30–50% foliar cover) stands of sagebrush may be appropriate as long as the primary objective is the improvement of nesting habitat.
- Plan livestock grazing to maintain desired structure of plant community, desired stubble height, and browse utilization.
- Do not concentrate livestock during the breeding season.
- Maintain large (>2 ha) patches of sagebrush where the sagebrush is 64–170 cm and sage density is between 10 and 50%.
- Maintain clumps of large (>1m), living sagebrush.
- Do not place livestock attractants within WHA.

Additional Management Recommendations

Protect sagebrush during weed control programs.

Implement protective measures to reduce the risk of fire that eliminates 100% of shrubs over a wide area.

Do not conduct widespread range burning or shrub clearing, unless a suitable number of productive, dense, and medium-sized shrubs, preferred by Sagebrush Brewer's Sparrow for nesting, are retained. Prescribed burning in patches will likely result in a mosaic of habitats of high value to Sagebrush Brewer's Sparrow.

Remove trees or perches where necessary.

Information Needs

1. More information on the specific habitat attributes preferred by breeding birds, particularly foraging habitat selection as well as basic information on habitat-related differences in reproduction and survivorship, and dispersal and migration (Fraser et al. 1999).
2. More surveys in suitable habitats to determine distribution, relative densities, and range boundaries. Particular attention should be paid to determining the extent of breeding activity in the lower Thompson River Valley to determine if singing males noted in this area are actually breeding.

Cross References

"Great Basin" Gopher Snake, Racer, Sage Thrasher

Requirements of the Long-billed Curlew and Grasshopper Sparrow may conflict with management prescriptions for the Sagebrush Brewer's Sparrow. The Long-billed Curlew requires more open grassland, and the Grasshopper Sparrow requires grassland with few or no shrubs.

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Sage Thrasher

Oreoscoptes montanus

Original[1] prepared by Martin Gebauer

Species Information

Taxonomy

The Sage Thrasher is the only species in the genus *Oreoscoptes* and no subspecies are recognized (Cannings 1998). It is likely more closely related to the mockingbirds of the genus *Mimus* than to thrashers in the genus *Toxostoma* (Reynolds et al. 1999).

Description

White wing bars, a white-cornered tail, and distinctive yellow eyes are distinguishing field marks of the Sage Thrasher. Plumage colouration is greyish-brown above and boldly streaked below. Worn late-summer birds show much less streaking. The bill is rather thrush-like and the tail is short for a thrasher. A poorly defined pale eyebrow line is also present (Godfrey 1986; NGS 1999).

Distribution

Global

The Sage Thrasher breeds from extreme south-central British Columbia, central Idaho, and south-central Montana south through the Great Basin to north-eastern Arizona, west-central and northern New Mexico, northern Texas, and western Oklahoma (Reynolds et al. 1999). It has also bred in southeastern Alberta and southern Saskatchewan (Godfrey 1986). The Sage Thrasher winters from central California, southern Nevada, northern Arizona, central New Mexico, and central Texas south to Baja Mexico and central Mexico (Howell and Webb 1995; Campbell et al. 1997; Reynolds et al. 1999).

British Columbia

In British Columbia, the Sage Thrasher is still reported annually from the Chopaka border crossing along Nighthawk Road, in the Richter Pass/Kilpoola Lake area, and almost annually from White Lake near Oliver (Nelson 1993; Cannings 2000). Singing birds have been reported from Vernon, the Thompson Valley at Lac du Bois, the Fraser Valley near Spences Bridge, and recently east of Oliver (Cannings 2000). A recent interesting record was of an old nest found west of Cache Creek along the Fraser River (Campbell et al. 1997), the first indication of breeding in this area.

Forest region and district

Southern Interior: Okanagan Shuswap

Ecoprovinces and ecosections

SOI: NOB, OKR, PAR, SOB, THB

Biogeoclimatic units

BG: xh1, xh2
IDF: xh1
PP: xh1, xh2a

Broad ecosystem units

AB, BS, CF, DP, SS

Elevation

300–500 m

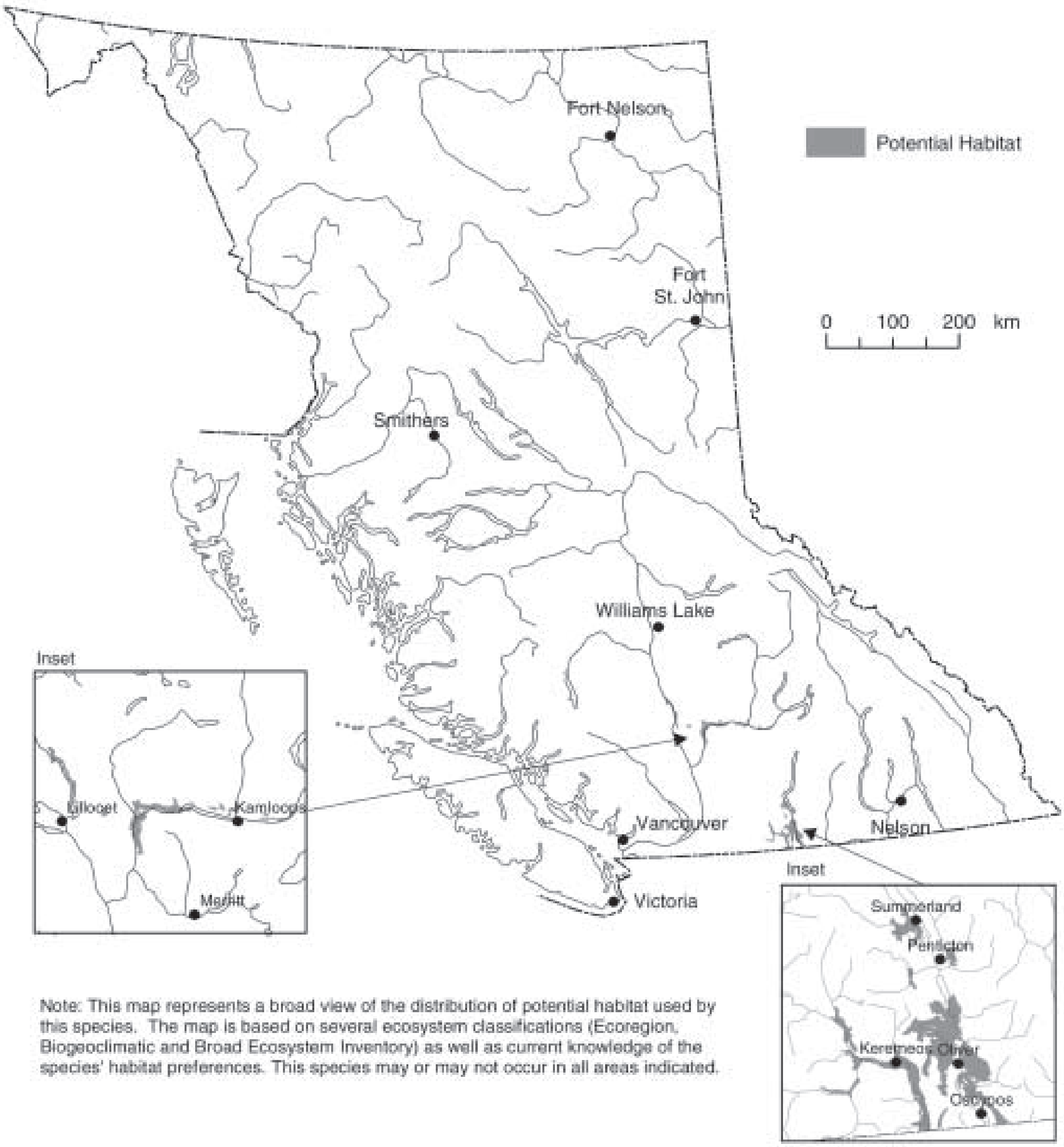
Life History

Diet and foraging behaviour

Since the diet consists of insects and other terrestrial invertebrates, as well as small fruits, especially berries (Dobkin 1992; Paige and Ritter 1999), the Sage Thrasher is considered to be an opportunistic

1 Volume 1 account prepared by R. Millikin.

Sage Thrasher
(Oreoscoptes montanus)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

feeder rather than a specialist (Reynolds et al. 1999). Sage Thrashers forage on the ground and glean from foliage (Dobkin 1992). They have been observed feeding at an ant mating swarm, digging for crickets and eating eggs, eating locusts and ants, eating saskatoon (*Amelanchier alnifolia*) berries, and breaking skin and eating from ripe grapes (Bent 1948; Stephens 1985; Nelson 1993; Blood 1995, Reynolds et al. 1999). Stephens (1985) provides a detailed analysis of Sage Thrasher diet in central Washington.

Reproduction

In British Columbia, dates for 21 clutches ranged from 1 June to 28 July, with 65% between 15 and 22 June. Clutch size ranged from one to five eggs with 71% having four or five eggs (Campbell et al. 1997). Reynolds (1981), Reynolds and Rich (1978), and Gooding (1970, cited by Reynolds et al. 1999) have reported average clutches of 3.5, 3.8, and 4.1, respectively. Clutches of up to seven eggs have been reported (Bent 1948). Incubation period ranges from 13 to 17 days with a mean of 15 days (Reynolds and Rich 1978; Reynolds 1981; Ehrlich et al. 1988). In British Columbia, dates for 15 broods ranged from 18 June to 11 August (Campbell et al. 1997). Brood sizes ranged from one to five young with 87% having two to four young. The nestling period generally ranges from 10 to 14 days (Reynolds 1981; Ehrlich et al. 1988; Campbell et al. 1997). Double brooding occurs occasionally (Reynolds 1981; Cannings et al. 1987).

Cowbird parasitism was not found in 24 nests with eggs or young in British Columbia (Campbell et al. 1997), and has only been reported once in other areas (Friedmann and Kiff 1985), likely because Sage Thrashers reject cowbird eggs quickly (Rich and Rothstein 1985).

Site fidelity

No information on nest site fidelity is available; however, Sage Thrashers regularly occur at several sites.

Home range

Mean territory sizes for two successive years in southeastern Idaho were 1.14 and 1.86 ha, respectively, with density estimates of 0.88 and 0.54 birds/ha, respectively (Reynolds 1981). Reynolds and Rich (1978) found territory sizes in Idaho ranging from 0.64 to 1.64 ha. In Washington, density estimates were 0.204 birds/ha in 1988, 0.212 in 1989, and 0.09 in 1990 (Dobler et al. 1996). In east-central Nevada, density estimates ranged between 0.12 and 0.4 birds/ha between 1981 and 1983 (Medin 1992). In the south Okanagan, territory sizes of 6–8 ha have been reported (R. Millikin, pers. comm., cited by Campbell et al. 1997).

Movements and dispersal

Migrants arrive in the Okanagan Valley as early as the first week of April, but typically in May or even early June (Campbell et al. 1997). Sage Thrashers appear to leave in late August or early September with the latest date being 29 September (Cannings et al. 1987; Cannings 2000).

No information is available on initial dispersal of birds from natal sites (Reynolds et al. 1999).

Habitat

Structural stage

2: herb
3a: low shrub

Important habitats and habitat features

Nesting

The Sage Thrasher is almost entirely dependent on sagebrush habitats during the breeding season (Braun et al. 1976; McAdoo et al. 1989; Knick and Rotenberry 1995a; Dobler et al. 1996), although breeding birds are occasionally noted in other shrub-steppe habitats and antelope-brush (*Purshia tridentata*) (Reynolds et al. 1999). Generally, abundance of breeding birds is positively correlated with sagebrush cover and negatively correlated with annual grasses (Wiens and Rotenberry 1981; Reynolds et al. 1999). Sites with medium-sized sagebrush (30–60 cm high), with some larger sagebrush (>1 m) for nesting are preferred (Rich 1980; Wiens and Rotenberry 1981; Castrale 1982; Petersen and Best 1991; Campbell et al. 1997; Paige and Ritter 1999). Shrub cover >15–20% may be important (Cannings 2000).

Nineteen nests in British Columbia ranged from 8 to 154 cm off the ground (Campbell et al. 1997) compared with most nests in south-central Idaho which were placed on the ground (Reynolds and Rich 1978; Rich 1978). Nests found by R. Millikin (pers. comm.) in the south Okanagan were a minimum of 26 cm off the ground. R. Millikin (pers. comm., cited by Campbell et al. 1997) found that sagebrush (*Artemesia tridentata*) selected by thrashers in the south Okanagan was larger (i.e., larger total height and width) than surrounding shrubs and larger than randomly selected shrubs on census transects, and that the mean density of sagebrush canopy at nest sites was approximately 70%. For nesting, individuals select shrubs that have the greatest total height (mean of 132 cm) and crown width (mean of 168 cm) and have a full crown (i.e., with no gaps). In several studies in Idaho, mean nest shrub height averaged from 69 to 89 cm with nests placed at 10–30 cm from the ground (Rich 1980; Reynolds 1981) and in larger shrubs than are available at random (Petersen and Best 1991). Castrale (1982) also found Sage Thrashers in habitat patches containing the largest shrubs, whereas McAdoo et al. (1989) did not find a correlation between Sage Thrasher abundance and shrub height. The most important factor in nest placement seems to be the amount of cover above the nest; nests are placed just below the densest vegetation in vertical profile (Rich 1978; Rich 1980; Reynolds 1981; Castrale 1982). Petersen and Best (1991) found that all nest bushes were 75% or more live and had few gaps in either the vertical or the horizontal profile. Large, continuous areas of sagebrush also appear to be important (MELP 1998).

The primary plant species used for nesting is sagebrush (Campbell et al. 1987). Other nest tree species reported in the Okanagan included an orchard peach tree (Cannings et al. 1987), red hawthorn (*Crateagus columbiana*), and saskatoon (*Amelanchier alnifolia*) (Campbell et al. 1997). Rabbitbrush, (*Ericameria bloomeri*) antelope-brush, and juniper (*Juniperus* spp.)have also been used for nesting in the United States (Blood 1995). The nest is a bulky structure comprised of sagebrush twigs, rootlets, bark strips, and plant stems, and lined with strips of sagebrush bark, fine grasses, horse and cattle hair, and fine rootlets (Cannings et al. 1987; Campbell et al. 1997). Several nests in the Okanagan were placed in trees with branches broken horizontally and nests were placed so that these branches would shade the nest from the sun (Cannings et al. 1987). R. Millikin (pers. comm.) found that cover above the nest was a critical habitat attribute. Shade platforms, constructed of twigs, are sometimes placed over the nest. A nest at White Lake had no shade platform when it was found with a clutch of five eggs, but 8 days later, when five young were present, a platform had been constructed with the addition of a twig "porch" as well (Cannings et al. 1987).

Foraging

During the breeding season, the Sage Thrasher breeds almost entirely in sagebrush habitats. During the non-breeding season, it has been observed feeding on residential lawns, orchards, and intertidal habitats in coastal areas (Cannings 1995; Campbell et al. 1997).

Conservation and Management

Status

The Sage Thrasher is on the provincial *Red list* in British Columbia. It is designated as *Endangered* in Canada (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at top of next page.)

Trends

Population trends

In British Columbia, Sage Thrasher populations have fluctuated over the last 100 years (Cannings et al. 1987). Before 1914, several pairs were present at White Lake, whereas in the 1920s, it appeared to be

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	BC	CA	ID	MT	OR	WA	Canada	Global
S1B	S1B	S5	S5B, S2N	S5B, S2N	S4	S3B, S2N	N1B	G5

absent from that location (Cannings et al. 1987). During 1931, an estimated 15 pairs were present at White Lake (Darcus 1932). The highest count at White Lake in the past 35 years was five pairs in 1969; they have averaged one to two pairs since then (Cannings et al. 1987). At Chopaka, an estimated 6–10 pairs nest annually, and several pairs are thought to nest south of Kilpoola Lake (Campbell et al. 1997; Cannings 2000). In 1990, the Chopaka, Richter Pass, Kilpoola Lake, and White Lake areas were thoroughly searched for 6 days but only four birds were found (Preston 1990). In 1991, the same area was searched and 11 Sage Thrashers were found singing (Cannings 2000). In 1993, single active nests were found at Kilpoola and Chopaka and seven adults were censused (R. Millikin, pers. comm.). In 1994, no active nests were located after extensive surveys and only four adults were censused. At its historical high, the British Columbia population of Sage Thrashers may have been as high as 30 or more pairs (Cannings 2000).

Sage Thrasher populations appear to be stable across their range. Regional significant population increases (between 1966 and 1999) have been noted in California (3.4%) on Breeding Bird Surveys (Sauer et al. 2000). Populations appear to be increasing in Colorado and Oregon (Sauer et al. 2000). Peripheral populations in Washington are on the decline because of large-scale habitat losses (Reynolds et al. 1999). Why Sage Thrashers are doing well in areas where other sagebrush obligates such as Sage Grouse (*Centrocercus urophasianus*) and Brewer's Sparrow (*Spizella breweri*) are declining is not known, but Sage Thrashers may tolerate habitat fragmentation better than other species (Knick and Rotenberry 1995b). In one area where sagebrush was sprayed and shrub cover was reduced from 28 to 4% and grass cover increased, Sage Thrashers declined only slightly in the short term (Weins and Rotenberry 1985).

Habitat trends

The area of suitable habitat available in British Columbia has slowly been declining over the past 70 years. In all, there has probably been <50% of habitat lost in the past 70 years, but development pressures on remaining highly suitable habitat, particularly in the Richter Pass and White Lake areas, are very high (Cannings 1995). Of the 27 478 ha of suitable habitat (much of which is suboptimal) in the south Okanagan and Similkameen valleys, 42% is private land, 28% Indian Reserve, 26% provincial Crown land, and 4% conservation lands (MELP 1998). Vineyard developments on the Inkameep Indian Reserve (Osoyoos Indian Reserve) have destroyed several hundred hectares of shrub-steppe habitat on the east side of Osoyoos Lake. This area is probably not optimal for Sage Thrasher since it is a mix of antelope-brush, big sagebrush (*Artemisia tridentata*), and rabbitbrush (*Ericameria nauseosus*), but thrashers have nested there in the past (Cannings 2000). Further agricultural, housing, and tourism developments threaten several more hundred acres of habitat in the reserve, although about 500 ha is proposed for protection. Urbanization and other developments are also impacting lowland habitats in other areas. Range improvement programs attempting to eradicate sagebrush through burning or mowing are impacting habitat quality in some areas.

Loss of suitable habitat in Washington State is of concern to Canadian populations. Approximately half of the historic area of sagebrush steppe in the United States has been lost to intensive agriculture, and only half of the remaining portion is in good condition (Vander Haegen et al. 1999; Cannings 2000).

Threats

Population threats

Small breeding population with a restricted distribution and unsecured habitat (Fraser et al. 1999).

Pesticide spraying may impact some populations. In the United States, local declines of grassland birds have been potentially linked to grasshopper control programs using pesticides (Paige and Ritter 1999). In shrub-steppe habitats in southern Idaho, Howe et al. (1996) found that malathion application had no observable direct effects, and only marginal indirect effects, through food-base reduction, on Brewer's Sparrow and Sage Thrasher nestling growth and survival. George et al. (1995) noted that pesticide treatments for grasshopper control had little effect on breeding bird communities in western rangelands.

Eggs and young are lost as a result of large mammalian predators, snakes, birds, and small mammals (Rotenberry and Wiens 1989; Reynolds et al. 1999). Rotenberry and Wiens (1989) considered Gopher Snakes (*Pituophis melanoleucus*) to be the principal predator of shrub-steppe breeding birds in the northern Great Basin.

Habitat threats

The primary limiting factor for Sage Thrasher in Canada is the loss, alteration, or degradation of sagebrush habitats. Loss of sagebrush habitat to agriculture, strip mining, and residential development in the United States (Braun et al. 1976), conversion to wheatfields in Washington State (Weber 1980), and agricultural development of dryland farming areas in Alberta (Cannings 2000) has caused great concern for Sage Thrasher using these environments. Complete replacement of native sagebrush habitat with crested wheatgrass (*Agropyron cristatum*) eliminates this species (Reynolds and Trost 1980, 1981). Even removal of only large sagebrush in breeding habitats can limit utilization by thrashers (Castrale 1982). Generally, land development activities that reduce sagebrush cover below 10% over large areas likely negatively affect Sage Thrashers (Braun et al. 1976).

Continued loss of sagebrush-steppe habitats in British Columbia is the primary threat to Sage Thrasher populations. Urbanization and development, particularly the rapid expansion of vineyards in the south Okanagan, housing developments in the Richter Pass area (Preston 1990), and sagebrush removal for improving range, are the greatest threats to sagebrush habitats. Heavy grazing pressure may affect Sage Thrasher populations negatively (Bradford et al. 1998), but thrashers are generally less sensitive to grazing pressure than other shrub-steppe bird species (Reynolds and Trost 1981; Kantrud and Kologiski 1982). Saab et al. (1995) reported several studies where heavy grazing resulted in a positive response in Sage Thrasher abundance. Historically, intensive range management programs, such as burning, mowing, herbiciding, and planting with crested wheatgrass, negatively impacted sagebrush habitats and the birds using these areas (Reynolds and Trost 1981; Wiens and Rotenberry 1985; Knick and Rotenberry 2000).

Fires may pose a threat to Sage Thrasher in terms of habitat loss, since sagebrush does not resprout after being burned (Castrale 1982). Kerley and Anderson (1995) found that burned areas still lacked thrashers 9 years after a fire, and herbicided areas still had suppressed thrasher populations 22 years after treatment. Petersen and Best (1987) found that Sage Thrasher abundance was unaffected by prescribed burning which resulted in a mosaic of burned and unburned areas in southeastern Idaho. The spread of cheatgrass (*Bromus tectorum*) has had a negative effect on Sage Thrasher populations through its influence on fire regimes in western grasslands (Knick and Rotenberry 1997). Cheatgrass, an annual species, tends to occur in large monocultures that are highly flammable, increasing the spread of fire and loss of sagebrush and other shrubs and accelerating the spread of annuals such as cheatgrass (Paige and Ritter 1999).

Potential effects of grazing include trampling of sagebrush plants by livestock.

Legal Protection and Habitat Conservation

The Sage Thrasher, its nests, and its eggs are protected in Canada under the federal *Migratory Birds Convention Act*, and in British Columbia, by the provincial *Wildlife Act*.

According to MELP (1998), only 4% (i.e., 1263 ha) of potential Sage Thrasher habitat is currently designated as conservation lands. Protected areas in the south Okanagan include the Nature Trust of British Columbia lands at White Lake. A number of new protected areas have been announced in the south Okanagan through the Okanagan-Shuswap Land and Resource Management Plan process. Some of the more important proposed parks for Sage Thrasher include White Lake Grasslands and South Okanagan Grasslands. Riparian and biodiversity guidelines under the results based code provide some protection of habitat for Sage Thrasher.

Identified Wildlife Provisions

Strategic management recommendations

- ❖ Protection of large areas of continuous sagebrush-steppe habitats is the most important approach required for recovery. Increasing the health of sagebrush-dominated rangelands, and providing suitable nesting habitat is essential in maintaining and increasing populations of Sage Thrasher in British Columbia. Protecting and enhancing these habitats will also benefit other sagebrush-obligate species such as the Sagebrush Brewer's Sparrow and Great Basin Pocket Mouse, and will address overall biodiversity objectives for the region.
- ❖ Since population trends of Sage Thrasher in Washington State will likely be reflected in trends in the Canadian population, recovery plans must be co-ordinated with recovery teams or responsible agencies in Washington State.
- ❖ Incorporate WHAs for the Sage Thrasher into grassland networks managed to maintain natural grassland communities. Adjacent wetlands and moist gullies, and a substantial proportion of remaining late-seral sagebrush communities should also be included in grassland networks.

Wildlife habitat area

Goals

Maintain suitable nesting habitat for multiple pairs.

Feature

Establish WHAs in areas with breeding densities of one or more pairs and selected high suitability historic breeding sites.

Size

Typically between 10 to 100 ha of shrub-steppe habitats, or up to 200 ha of discontinuous habitat.

Design

A WHA should include sagebrush-dominated shrub-steppe habitats with a mosaic of habitat attributes including a low amount of bare ground (10–20%), moderate densities of shrubs (10–30%), and clumps of big sage (2–10 shrubs >1 m in height).

General wildlife measures

Goals

1. Maintain the integrity of nesting habitat by retaining density and structure of sagebrush habitat.
2. Minimize fires and other activities that remove 100% shrub cover.

Measures

Access

- Do not construct roads unless there is no other practicable option.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to minimize crown breakage, maintain the desired sagebrush cover.
- Protect large sagebrush patches during weed control programs.
- Maintain clumps of large (>0.9 m in height and >1.1 m in width) living sagebrush.
- Do not place livestock attractants within WHA.

Additional Management Considerations

Maintain low-elevation, dry shrub-steppe. Avoid widespread range burning and clearing of native shrubs such as sagebrush and antelope-brush in important breeding areas.

Avoid high intensity grazing that negatively impacts shrubs and reduces shrub cover required by Sage Thrashers.

Implement protection measures to reduce the risk of fire which eliminates 100% of shrubs.

Prevent invasion of cheatgrass into intact shrub-steppe habitats.

Minimize further removal of sagebrush for residential, commercial, and agricultural development. Re-establish sagebrush communities where possible.

Information Needs

1. Foraging behaviour and the impact of cattle grazing on availability of insect prey and shrubs used for nesting.
2. Habitat attributes of nest sites and breeding territory.
3. The impact of tree encroachment in sagebrush-steppe habitats on habitat availability for Sage Thrasher.

Cross References

"Great Basin" Gopher Snake, Racer, "Sagebrush" Brewer's Sparrow

Requirements of the Long-billed Curlew and Grasshopper Sparrow may conflict with management prescriptions for Sage Thrasher. The Long-billed Curlew requires more open grassland, the Grasshopper Sparrow requires grassland with few or no shrubs.

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Yellow-breasted Chat

Icteria virens

Original[1] prepared by Martin Gebauer

Species Information

Taxonomy

The Yellow-breasted Chat is the only species of the Tribe Parulini (i.e., wood warblers) in the genus *Icteria* (Sibley 1996). According to Sibley (1996), an additional 119 species of wood warbler are found in the Tribe Parulini worldwide. Although placed in the family Parulidae, its relationship to other avian groups has been controversial over the years, being first described by Linnaeus in the thrush genus *Turdus* (Cannings 2000). Two subspecies of Yellow-breasted Chat are recognized: *I. virens virens* that occurs in southeast Canada and the eastern United States and *I. virens auricollis* that occurs in western North America (Cannings 1998).

Description

The Yellow-breasted Chat is the largest warbler occurring in British Columbia. Upper parts, including the wings and tail, are a uniform greyish olive-green colour, whereas the throat, breast, and underwing coverts are bright yellow. Remaining underparts are white with sides tinged with buffy grey. A bold white stripe from the bill back over the eye is distinct. White patches are also present under the eye and from the base of the bill back over the jaw. Lores are black in males and grey in females. The Yellow-breasted Chat often sings at night, similar to some of the mimic thrushes, and has the lowest voice of any American wood warbler (Aslop 2001). The unmusical song is comprised of a jumble of harsh, clucks, rattles, whistles, and squawks (Godfrey 1986; NGS 1999). Yellow-breasted Chats inhabit dense thickets and brush and are retiring and shy, making them very difficult to observe. Their loud song is often the only indication an observer has of their presence in an area.

Distribution

Global

The Yellow-breasted Chat breeds from southern British Columbia, southern Alberta, southern Saskatchewan, and southern Ontario south through most of the United States to west and central Baja California and the central Mexican mainland (Howell and Webb 1995; Campbell et al. 2001). It winters from southern Baja California, southern Texas, and Florida south to Panama (Howell and Webb 1995; Sauer et al. 2000).

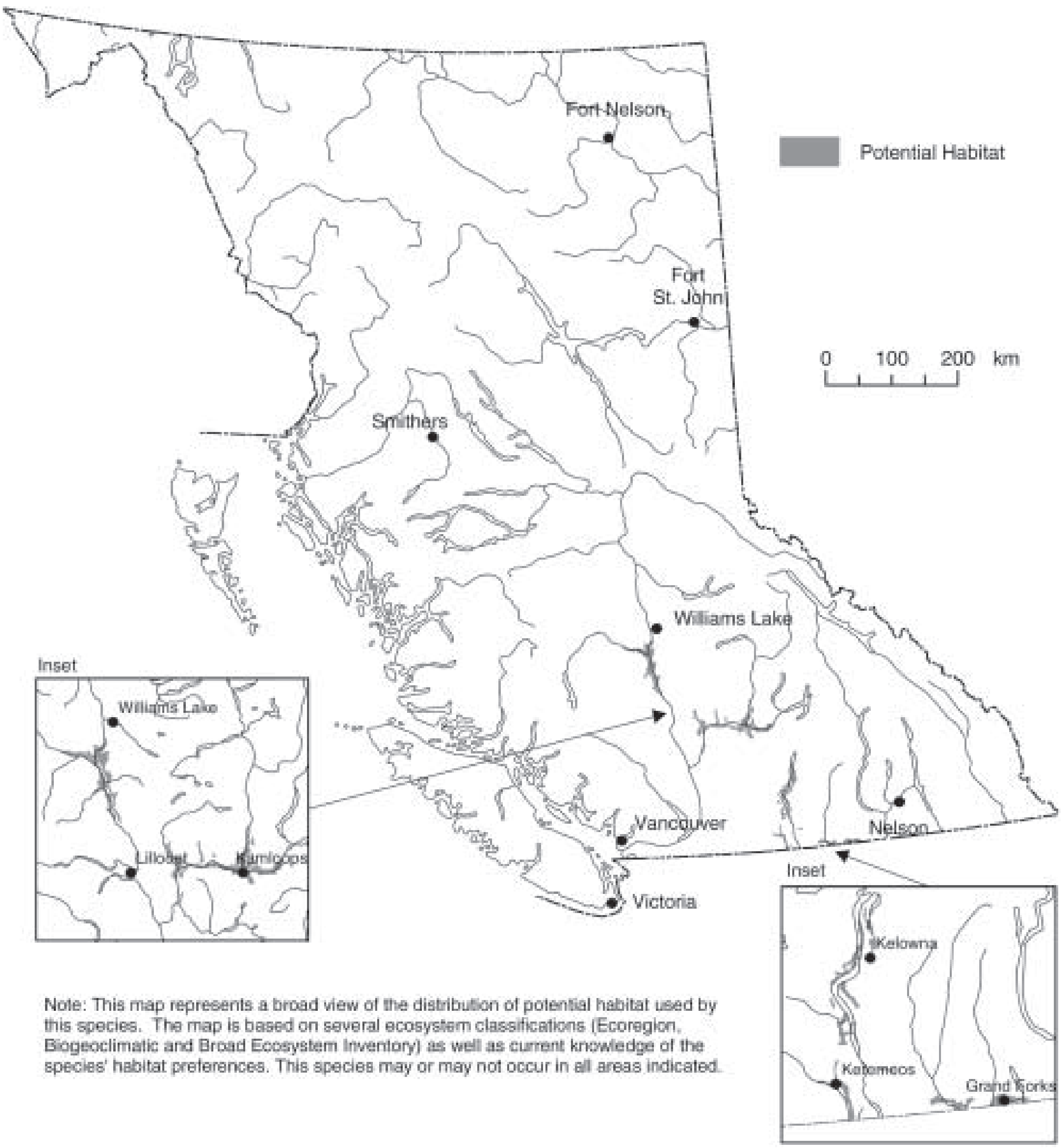
British Columbia

The Yellow-breasted Chat breeds in the extreme southern portions of the province in the Okanagan and Similkameen valleys (Cannings et al. 1987; Campbell et al. 2001). Singing males are occasionally reported from Creston and the Thompson and Fraser River valleys, as far north as the Chilcotin River (Fraser et al. 1999). A possible historic breeding population at Ashcroft has been extirpated (Campbell et al. 2001). Two singing males were recently reported singing in the Pavilion area of British Columbia but evidence of breeding was not confirmed (Cannings 2000). Chats occur irregularly in the lower Fraser Valley with one breeding record at Mission in 1966 (Cannings 2000). Recent unconfirmed reports suggest that a small breeding population has become established near Mission and Chilliwack (MOF and MELP 1998). A singing male was observed at Colony Farm regional park, Coquitlam on 23 June 2001 (C. Bishop, pers. comm.).

1 Volume 1 account prepared by J. Cooper.

Yellow-breasted Chat

(Icteria virens)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Forest regions and districts

Coast: Chilliwack

Southern Interior: 100 Mile House (possible), Cascades, Central Cariboo, Kamloops, Kootenay Lake, Okanagan Shuswap

Ecoprovinces and ecosections

CEI: suspected in FRB

GED: likely in FRL

SIM: possible in SCM

SOI: OKR, NOB, SOB, SOH, possible in THB

Biogeoclimatic units

BG: xh, xw

CWH: dm

PP: dh, xh

Broad ecosystem units

BS, CF (hedgerows), CR

Elevation

In British Columbia, the Yellow-breasted Chat occurs from sea level to 70 m elevation on the Coast and between 250 and 800 m elevation in the Interior (Campbell et al. 2001).

Life History

Diet and foraging behaviour

Insects are the primary food source during the breeding season, with berries becoming a more important food source in summer. Young are fed exclusively insects (Ehrlich et al. 1988). Petrides (1938) found that food brought to young in Washington, D.C., consisted primarily of caterpillars. Yellow-breasted Chats forage in the foliage and lower branches of low shrubs and herb layers of thickets (Cannings 1995). Chats are the only warbler species known to hold food with their feet (Aslop 2001).

Reproduction

Dates for 19 clutches in British Columbia ranged from 15 May to 02 July, with 58% recorded between 15 June and 25 June (Campbell et al. 2001). Of nine nests observed by Bishop (pers. comm., 2001) in the south Okanagan in 2001, seven (77%) had clutch dates ranging from 10 June and 20 June, and one clutch was observed on 04 July 2001. Size of 16 clutches ranged from one to four eggs with 88% having three or four eggs (Campbell et al. 2001). Bishop (pers. comm., 2001) found six of nine nests (66%) in the south Okanagan contained clutches of three to four eggs. Clutches of three to four eggs were also most common in an intensive study of chat populations in southern Indiana (Thompson and Nolan 1973).

Incubation period is reported as being 11–12 days (Ehrlich et al. 1988; Aslop 2001). Dates for 12 broods in British Columbia ranged from 29 May to 31 July (Campbell et al. 2001). In the south Okanagan in 2001, dates for eight broods ranged from 07 June to 12 July (C. Bishop, pers. comm., 2001). Sizes of five broods in British Columbia ranged from one to three young (Campbell et al. 2001). The fledgling period is approximately 9 days (Ehrlich et al. 1988), although Bishop (pers. comm., 2001), reported one nest with a fledgling period of 11–12 days. In southern Indiana, Thompson and Nolan (1973) found that 31 of 39 breeding pairs attempted second broods. The spread of clutch initiation dates (i.e., 12 May to 23 June) in the Okanagan Valley (Cannings et al. 1987) suggests that chats may attempt to raise two broods per season in British Columbia as well (Cannings 1995). Bishop (pers. comm., 2001) had concrete evidence of a second brood in one nest in the south Okanagan in 2001, and noted regular singing and flight displays in males following fledging of a first brood.

Yellow-breasted Chats are frequent hosts of Brown-headed Cowbird (*Molothrus ater*) throughout their range (Friedmann 1963, as cited in Campbell et al. 2001). Thirteen percent of 23 nests found in British Columbia (Campbell et al. 2001) and 31% of 42 nests in Missouri were parasitized by cowbirds (Burhans and Thompson 1999). Bishop (pers. comm., 2001) indicated that as many as 55% (5/9) of nests observed in the south Okanagan in 2001 appeared to have been parasitized by cowbirds. Interestingly, young appear to be fledged at a similar rate from parasitized nests as unparasitized nests (Burhans and Thompson 1999), and growth rates do not appear to be reduced in parasitized nests

(Thompson and Nolan 1973). However, two parasitized chat nests in British Columbia were deserted before hatching (Campbell et al. 2001) and Bishop (pers. comm., 2001) found that 40% (2/5) of nests with cowbird presence were depredated early in the nesting cycle.

Site fidelity

Thompson and Nolan (1973) found that no females and only 11% of breeding males returned to their study area in southern Indiana in the years following first capture, suggesting that site fidelity in chats is low. Banding of 22 adult and chick chats in the south Okanagan in 2001 (C. Bishop, pers. comm., 2001) will provide interesting data if banded birds are recaptured in 2002.

Home range

A survey of known chat territories in the south Okanagan in 2000 detected singing male chats in territories estimated to be 0.1–24 ha (Bezener 2001). Bishop (pers. comm., 2001) found that territory size of 25 pairs in the south Okanagan ranged from 0.2 to 5.64 ha, with a mean territory size of 0.99 ha. In southern Indiana, Thompson and Nolan (1973) found that mean territory size ranged between 1.12 and 1.58 ha. Dennis (1958) reported breeding territory sizes of 1.25–2.5 acres in Virginia (i.e., ~0.5–1.0 ha).

Movements and dispersal

Most Yellow-breasted Chats arrive in southern British Columbia in mid-May (Cannings et al. 1987), but some arrive as early as late April (Campbell et al. 2001). No discernible autumn movements have been noted since reports of birds drop sharply once birds stop singing (Campbell et al. 2001). Most birds have likely left the province by early August soon after young have fledged (Cannings et al. 1987).

Habitat

Structural stage

3a: low shrub
3b: high shrub

Important habitats and habitat features

Breeding

Yellow-breasted Chats breed in dense thickets around woodland edges, riparian areas and overgrown clearings or clearcuts (Annand and Thompson 1997; Twedt et al. 1999; Campbell et al. 2001). Populations in British Columbia are associated with riparian habitats, particularly black cottonwood (*Populus balsamifera*) and water birch (*Betula occidentalis*) stands with dense understorey thickets of rose, willow, and common snowberry (*Symphoricarpos albus*). Chats also occupy dense forest-edge thickets where Columbian hawthorn (*Crataegus columbiana*), trembling aspen (*Populus tremuloides*), choke cherry (*Prunus virginiana*), snowberry, and Prairie Rose (*Rosa woodsii*) provide a dense undergrowth (Campbell et al. 2001). Thickets of rose, snowberry, or Himalayan Blackberry (*Rubus discolor*) in uncultivated corners of fields, orchards, and vineyards also provide some habitat (Campbell et al. 2001). Density of shrub cover is apparently more important than species composition of a thicket. Gibbard and Gibbard (1992) found that chats frequented rose thickets ranging in size from 9 to 195 m^2 and an average height of 1.25 m. Trees growing within or close to the thicket generally did not exceed 6 m in height, and large shrubs were usually 3.5 m in height. In the south Okanagan in 2001, Bishop (pers. comm., 2001) found continuous rose patches around nests ranging from ~0.3 to 135 m^2. Chats were generally not found in riparian habitats heavily dissected by cattle trails, in areas with overstorey of large trees, and areas with a high level of traffic noise (Gibbard and Gibbard 1992). Bishop (pers. comm., 2001) found that some territories in the south Okanagan were fragmented by current or recent livestock use and were occasionally close to a busy highway (i.e., #97).

Nests are well concealed in dense shrubbery usually 0.6 to 0.9 m above the ground, are often overgrown with vines, and are under a canopy of cottonwood or water birch (Bent 1953; Bryan et al. 2001; Campbell et al. 2001). The heights of nine nests monitored by Bishop (pers. comm., 2001) in the south Okanagan in 2001 ranged from 0.4 to 1.15 m with the overall average being 0.73 m. The nest is made of coarse leaves, bark, and plant stems, and lined with fine grasses (Godfrey 1986). Most nests in British Columbia were located in rose bushes (Cannings 1995), but snowberry and willow have also been used (Campbell et al. 2001). Burhans and Thompson (1999) found that chats selected larger shrub patches to locate their nests despite increased rates of parasitism. Losses to parasitism were apparently balanced by reduced depredation rates in larger patches. However, Bishop (pers. comm., 2001) found that a number of nests were close to patch edge (range from 0.08 to 10.0 m) with the average being 2.23 m.

Foraging

Yellow-breasted Chats forage within dense riparian breeding habitats during the nesting season. During migration or on their wintering grounds, they can be found in a wide variety of shrubby thickets and densely vegetated riparian areas (Skagen et al. 1998).

Conservation and Management

Status

The Yellow-breasted Chat is on the provincial *Red List* in British Columbia. The British Columbia population of the Yellow-breasted Chat was upgraded from *Threatened* to *Endangered* status in November 2000 (COSEWIC 2002).

Trends

Population trends

Breeding Bird Survey results for 1966 to 1999 (Sauer et al. 2000) indicate no significant changes in U.S. population of Yellow-breasted Chat, but significant increases in Canada (12.7%/yr; $p < 0.01$). Significant declines have been observed in several eastern states including Illinois, Maryland, Ohio, Pennsylvania, Tennessee, West Virginia, and Kentucky. Significant population increases have been documented in Georgia, Mississippi, and North Dakota. An analysis of Breeding Bird Surveys in British Columbia for 1966 to 2000 did not reveal a significant trend (Sauer et al. 2000).

In British Columbia, Cannings (2000) estimated a stable population of 25–30 pairs. Surveys in 2001 located 36 singing males in the Okanagan (highest count to date), 19 occupied territories, and 9 active nests (C. Bishop, pers. comm., 2001). A 1999 survey in the south Okanagan and lower Similkameen valleys in 1999 yielded 19 singing males, compared with the 15 singing males reported by Gibbard and Gibbard (1992). Although results from the various surveys differed substantially, differences are more likely due to variable survey intensity than to changing populations. Cooperation with First Nations in 2001 permitted surveys on Reserve lands, resulting in new location records (C. Bishop, pers. comm., 2001). Taverner (1922) stated that "the [Okanagan] valley is famous for chats…in spite of their apparent scarcity there were enough of them about to seize upon and occupy any specially

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	BC	CA	ID	MT	OR	WA	Canada	Global
S3B	S1B	S3	S5B, SZN	S5B, SZN	S4?	S4B, SZN	N4B	G5

desirable locality that might be vacant." Population declines since the early part of the 19th century are largely due to loss of suitable riparian and shrubland habitats due to land development activities (Cannings 1995). Bishop (pers. comm., 2001) suggests that increased livestock use in previously "suitable" Yellow-breasted Chat habitats results in habitat damage through trampling and browsing, and an increase in Brown-headed Cowbird parasitism.

Habitat trends

Breeding habitat in British Columbia is primarily confined to extensive riparian habitats along the Similkameen River south of Keremeos, the old oxbows of the Okanagan River, and Inkaneep Creek on Osoyoos First Nations lands. Habitats associated with the Okanagan River have been heavily impacted in the last 50 years. An estimated 15% of the pre-European quantity of riparian vegetation suitable for chats remains in southern British Columbia (C. Bishop, pers. comm., 2001). Many riparian habitats were severely altered when the Okanagan River was channelized between 1954 and 1958 (Cannings 2000). Flood control effected by channelization permitted landowners to remove riparian habitats and use the land for agriculture. In the last 10 years, incremental loss of riparian habitat has been small; however, a proposed golf course development on the west side of the Okanagan River in Penticton threatens one or two breeding pairs of chats, representing approximately 10% of the B.C. population (Cannings 2000). Surveys of 119 potential sites only found singing males at 14 sites (Gibbard and Gibbard 1992).

Of 5078 ha of habitat considered suitable for chats in the south Okanagan, ownership includes provincial Crown land (6%), Indian Reserve (45%), private land (44%), and conservation lands (5%)(MELP 1998). Participation of "conservation minded landowners, many of whom desire to enhance and rehabilitate areas for chats, represents a critical link in maintaining viable Yellow-breasted Chat habitats.

Threats

Population threats

Pesticide spraying may be a problem in some areas because of the insectivorous feeding habitats of Yellow-breasted Chats (Cadman and Page 1994). Approximately 94% of nest failures reported in a study by Thompson and Nolan (1973) were attributed to predators including snakes, Blue Jay (*Cyanocitta cristata*), and Eastern Chipmunk (*Tamias striatus*). One south Okanagan nest with chicks showed indications of snake "punctures" on dead young (C. Bishop, pers. comm., 2001). In several nests in a study by Thompson and Nolan (1973), egg disappearance closely coincided with deposition of cowbird eggs. Bishop (pers. comm., 2001) found that 40% of five nests in the south Okanagan thought to be parasitized by Brown-headed Cowbirds were depredated early.

Habitat threats

Low elevation riparian habitats are threatened by continuing loss and fragmentation due to agricultural and urban development (Cannings 1995). Any activity that results in the loss or reduction in dense shrubby areas can be detrimental. Livestock grazing, which may result in trampling or damage to riparian thickets, may thus be detrimental (Eckerle and Thompson 2001). Thinning and logging of riparian woodlands is not a significant threat to most chat breeding areas in British Columbia.

Legal Protection and Habitat Conservation

The Yellow-breasted Chat, its nests and eggs are protected in Canada and the United States from hunting and collecting under the *Federal Migratory Birds Act* of 1917. In British Columbia, it is protected under the provincial *Wildlife Act*.

Protected areas in the south Okanagan include the Vaseux Bighorn National Wildlife Area, South Okanagan Wildlife Management Area, and Inkaneep Provincial Park. According to MELP (1998), 5% (i.e., 260 ha) of potentially suitable Yellow-breasted Chat habitat is currently designated as conservation lands in the south Okanagan.

A comprehensive riparian management plan for neotropical migrants is being developed by the Canadian Wildlife Service.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Maximize retention and connectivity of riparian habitats and natural grassland communities.

Wildlife habitat area

Goals

Maintain breeding and foraging habitats in areas with aggregations of one or more pairs of Yellow-breasted Chats and selected high suitability historic breeding aggregations.

Feature

Establish WHAs in areas with current breeding concentrations or at historical breeding concentrations in high capability or high suitability habitat.

Size

The size of the WHA will depend on the number of breeding pairs. Between 0.1 and 6 ha of suitable habitat should be secured for each breeding pair. Larger WHAs are more likely to maintain features and conditions for nesting.

Design

The WHAs should include the entire area of thickets that may be used by chats and degraded riparian areas that can be rehabilitated. When fencing of the WHA is being considered, ensure security of chats from predators by providing space between breeding habitat and fence.

General wildlife measures

Goals

1. Maintain or rehabilitate riparian thicket habitat.
2. Ensure livestock do not fragment or trample thicket habitat.
3. Maintain WHA in a properly functioning condition.

Measures

Access

- Do not build new roads and stream crossings unless there is no practicable option.

Pesticides

- Do not use pesticides.

Range

- Provide alternate water, forage, and salt licks for livestock to reduce impacts to wetland and riparian habitats.
- Exclude livestock from riparian or associated riparian habitats within the WHA. If there is no other practicable option to prevent livestock use (i.e., changing timing and intensity of grazing), fencing could be required by the statutory decision maker.

Additional Management Considerations

Rehabilitate riparian habitats damaged by cattle by excluding cattle and revegetating cleared areas with new wild rose thickets and other riparian shrub vegetation (see Bezener 2001). Construct fences between upland areas and riparian habitats to exclude cattle.

Plant wild rose and other shrub species within protected areas, such as Vaseux Lake and Osoyoos Oxbow areas, and inside exclusion fences.

Information Needs

1. Distribution, relative densities, and population trends.
2. Quantification of critical habitat characteristics, particularly those that support breeding chats.
3. Information on usefulness of fencing riparian areas and testing of riparian community response to fencing treatments in riparian corridors of varying widths.

Cross References

Fringed Myotis, "Great Basin" Gopher Snake, Lewis's Woodpecker, Tiger Salamander, water birch–red-osier dogwood

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"Columbian" Sharp-tailed Grouse

Tympanuchus phasianellus columbianus

Original prepared by R.W. Ritcey and Doug Jury

Species Information

Taxonomy

The Columbian Sharp-tailed Grouse is one of six subspecies of Sharp-tailed Grouse, a species found only in North America. Three subspecies occur in British Columbia: *Tympanuchus phasianellus columbianus*, *T. phasianellus caurus*, and *T. phasianellus jamesi*.

Description

Medium-sized grouse (length 41–48 cm; weight 596–1031 g); both sexes have similar plumage; overall cryptically coloured; white breast with several V-shaped brown markings; head, neck, and back are heavily barred dark brown, black, and buff; wedge-shaped tail; two middle tail feathers extend past other tail features. During display, males can be identified by pink air sacs on either side of neck and by linearly marked central rectrices (Tirhi 1995, Connelly et al. 1998).

Distribution

Global

Sharp-tailed Grouse range from north-central Alaska and the Yukon east to central-western Quebec, south through the western North American interior to eastern Oregon, northern Utah, Colorado, Minnesota, and northern Michigan. The Columbian Sharp-tailed Grouse occurs in parts of the intermountain or Great Basin region of western North America from southcentral British Columbia south to Colorado. In Idaho, Montana, Utah, and Wyoming, it inhabits <10% of its historic range; in Colorado and Washington from 10 to 50% of its original range; in British Columbia the estimate is from approximately 80% (Tirhi 1995).

British Columbia

In British Columbia, the Columbian subspecies is found from near Vanderhoof south to Merritt, east to the Cariboo Mountains, and west to the Coast Ranges.

Forest region and districts

Northern Interior: Vanderhoof

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin, Kamloops, Okanagan Shuswap, Quesnel, Rocky Mountain

Ecoprovinces and ecosections

CEI: BUB, CAB, CCR, CHP, FRB, NAU, QUL

SBI: BAU, NEL

SIM: EKT, UCV

SOI: GUU, NIB, NOB, NOH, NTU, OKR, PAR, SHB, SOB, SOH, STU, THB, TRU

Biogeoclimatic units

BG: xh1, xh2, xh3, xw, xw1, xw2

IDF: dk1, dk2, dk3, dk4, dm1, dm2, mw1, mw2, mw2a, un, xh1, xh1a, xh2, xh2a, xh2b, xm, xw, xw2

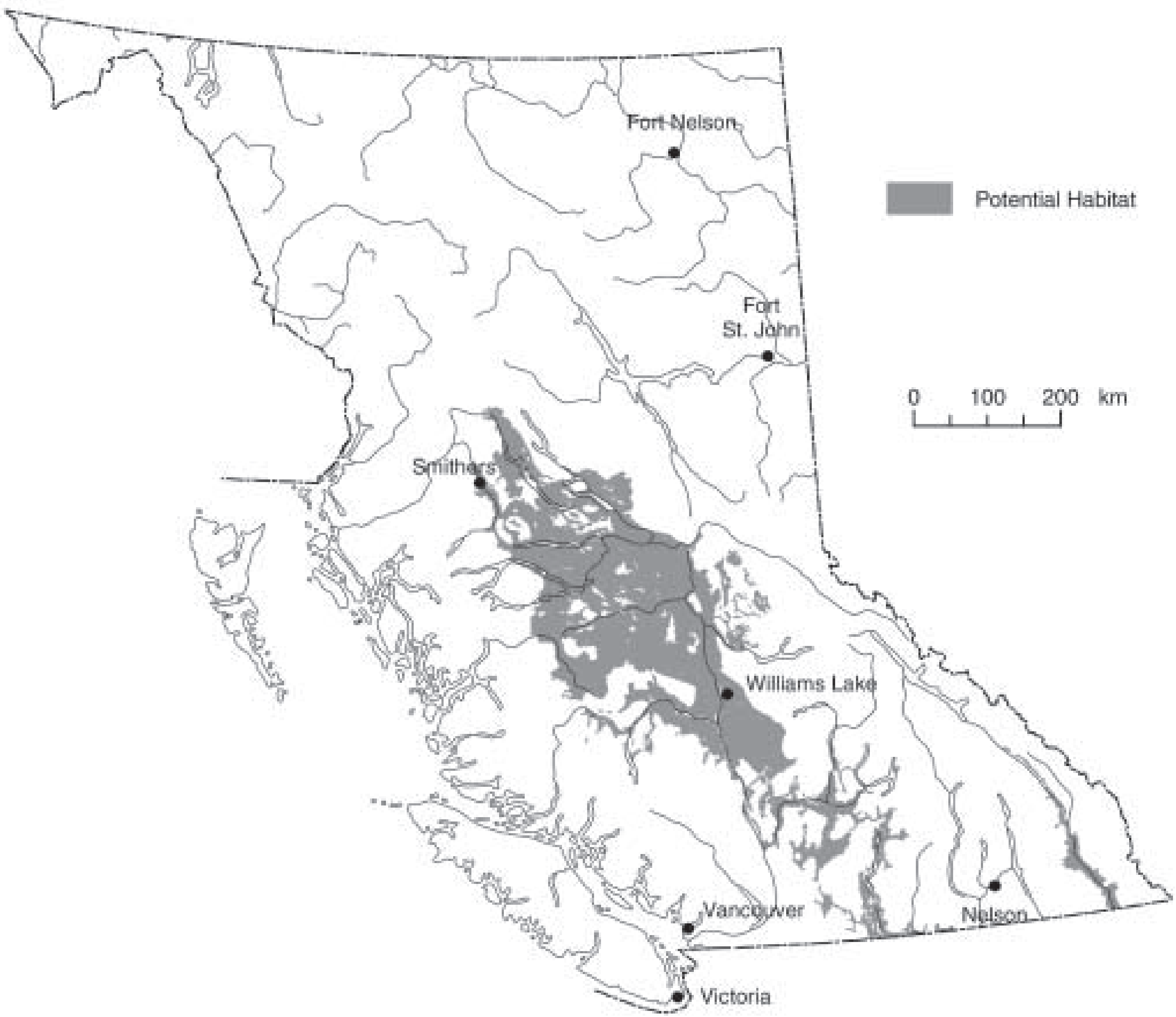
PP: dh1, dh2, xh1, xh1a, xh2, xh2a

SBS: dk, dw2, dw3, mh

SBPS: xc

Sharp-tailed Grouse - subspecies *columbianus*

(Tympanuchus phasianellus columbianus)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Broad ecosystem units

Season									
Breeding		Nesting		Summer		Fall		Winter	
Unit	Structural stage	Unit	Structural stage	Unit	Structural stage	Unit	Structural stage	Unit	Structural stage
BS	all	AC	2,3	AC	2,3	AC	all	BS	all
DF	2,3	BS	all	BS	all	BS	all	CF	all
DL	2,3	CF	all	CF	all	CF	all	CR	all
LP	2,3	DL	2,3	DL	2,3	CR	all	DL	2,3,4
PP	2,3	DP	2,3	DP	2,3	DL	2,3,4	DP	all
		PP	2–7	PP	2,3	LP	2,3,4	FE	all
						PP		ME	all
								MR	all
								PP	all
								SC	all
								SH	all
								SS	all
								SW	all

Elevation (breeding)

275–1190 m

Life History

Diet and foraging behaviour

Sharp-tailed Grouse feed on a variety of plants and insects depending upon the season. The general pattern of food intake appears to be similar between Sharp-tailed Grouse occupying grasslands or clearcuts. In spring, Sharp-tailed Grouse eat forbs, grasses, and insects. Insects are more important in the summer and fall when they are more available. Chicks also feed primarily on insects and other invertebrates.

In early fall, Sharp-tailed Grouse of southern British Columbia eat mainly greens of several leafy plant species with grass leaves making up a lesser part of the diet. As fall progresses, berries become more important although green leaves are available and eaten until freeze up. Insects, chiefly grasshoppers, are a minor food item in fall. Sharp-tailed Grouse begin to eat leaves and twigs of deciduous trees with the approach of winter.

In winter, they feed primarily on buds and catkins of deciduous trees and shrubs. Of lesser importance are fruits and berries. Although Sharp-tailed Grouse are often found in open grassland habitats during winter, grass seeds appear to be a minor component of the diet during that season. Cultivated grains can supply quality winter food but little is grown in the range of Columbian Sharp-tailed Grouse in British Columbia.

For grassland populations, the most important forage species are snowberry (*Symphoricarpus alba*), rose (*Rosa species*), and dandelion (*Taraxacum officinale*). Important browse species include water birch (*Betula occidentalis*), trembling aspen (*Populus tremuloides*), saskatoon (*Amelanchier alnifolia*), and choke cherry (*Prunus virginiana*). Seeds from any source appear to be unimportant in the fall diet of grassland Sharp-tailed Grouse in British Columbia.

For populations utilizing clearcuts, the most important shrub species are kinnikinnick (*Arctostaphyllos uva-ursi*), common juniper (*Juniper communis*), and prickly rose (*Rosa acicularis*). The most commonly eaten browse species is scrub birch (*Betula glandulosa*) and to a lesser extent, water birch and aspen.

Reproduction

Breeding males congregate at specific areas to display and attract females. Nearly all breeding occurs at these sites, known as leks. When a choice is available, females select males positioned near the centre of the lek. Calls from the leks may be heard for a distance of up to 1.5 km (Ritcey 1995).

Females lay a first clutch at 11 months of age and produce annually with a mean clutch size of 12.8. A high percentage of eggs are fertile and nearly all females nest. Re-nesting is common if the nest is destroyed leading to a second or sometimes third nesting attempt. There is one brood per year. Because of their high reproductive rate and variability in survival of young, sharp-tailed grouse populations show pronounced year-to-year fluctuations in fall numbers.

Site fidelity

Leks are traditional and may be used for many years if habitat remains unchanged and disturbance by humans is not too great. Males may tolerate most disturbances but females avoid disturbed leks (Baydack and Hein 1987).

Home range

Despite the ability for long flight, they may have relatively limited home ranges where year-round requirements are met within a small area. For example, in Montana males had a home range of 1.7 km^2 while females were 3.6 km^2 (Cope 1992); in Idaho during the summer both sexes used a 1.87 km^2 range (Marks and Marks 1987) and in British Columbia year round home ranges were 4.9 km^2 (Van Rossum 1992). Nests have been located within 100 m of lek and >3 km from lek sites but most are within 1.6 km of lek (Marks and Marks 1987; Meints 1991; Giesen and Connelly 1993).

Dispersal and movements

Sharp-tailed Grouse are considered non-migratory although they are well adapted to undertake long flights to obtain seasonal foods within their home range. Banded Sharp-tailed Grouse in South Dakota travelled up to 148 km; juveniles travelled farther than adults and females travelled farther than males (Robel et al. 1972).

Habitat

Structural stage

See *Broad ecosystem units* table above.

Important habitats and habitat features

Breeding

Openness is an important requirement of a dancing ground (lek) because it enable the detection of predators and in attracting grouse to the lek by seeing and/or hearing displaying males. Leks are often located on ridge tops or elevated ground but not necessarily the highest ground available. Seclusion is an important attribute of successful leks.

Nesting

Adequate cover to conceal nests is crucial. Extensive areas of nesting habitat are necessary to prevent nest predators concentrating their searches. Residual grass cover with a minimum height of 25 cm is recommended for nesting habitat for grassland populations (Meints et al. 1992). Jury (pers. comm.) found four of five nests of radio-marked Sharp-tailed Grouse in clumps of residual bluebunch wheatgrass (*Pseudoroegneria spicata*) while a fifth was in a dense stand of Kentucky blue grass (*Poa pratensis*). Rough fescue (*Festuca campestris*) is also often dominant at many sites in British Columbia (D. Fraser, pers. comm.) There is conflicting information on characteristics of nesting habitat for “Columbian” Sharp-tailed Grouse in the U.S. Cope (1992) found nests located in native grass cover and only one nest found within 50 m of shrub cover while Tihri (1995) cited several studies in other states where shrub cover was the preferred nesting habitat.

Summer (brood)

Areas with an abundance of ground dwelling insects are vital for chicks. A high percentage of ground cover was a characteristic of brood rearing areas in Montana (Cope 1992). Tihri (1995) cited studies that found shrub habitats to be preferred for raising broods in some areas while grass/forb habitats were used elsewhere. Few data are available on preferred brood habitats in British Columbia.

Fall

Berries are important both for grassland and clearcut populations. Disturbed areas such as roadsides and landings with abundant greens such as clovers, dandelion, and yarrow are heavily used. Lodgepole pine stands with developed or developing canopies have heavier crops of kinnikinnick than new clearcuts, especially in dry situations. Also in the first snowfalls of winter, locating berries and moving about in the understorey of those stands is facilitated by snow interception of the canopy.

Winter

Riparian areas rich in deciduous shrub and tree species provide berries, palatable catkins, and twigs for important winter feeding habitat. Shrub fens and shrub carrs with low growing scrub birch provide wintering habitats for clearcut populations (Ritcey 1990). Snow roosting by Sharp-tailed Grouse is a common strategy to conserve energy in winter (Evans and Moen 1975). Leupin and Murphy (2000a) found Sharp-tailed Grouse to roost in upland rose patches in the absence of snow. Snow roosting areas were all found near deciduous/riparian and shrub cover. Gratson (1988) found roosting in Wisconsin to be in open sedge-meadows and shrub-marshes where there is little alternate prey to attract predators.

Conservation and Management

Status

The Columbian Sharp-tailed Grouse is on the provincial *Blue List* in British Columbia. Its status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	OR	Canada	Global
S2S3	S3	S1	S1	N2N3	G4T3

Trends

Population trends

Concern over Sharp-tailed Grouse populations was noted as early as 1905. By the mid-20th century, populations had declined to extinction through much of the Columbian subspecies range in the southern part of the province (Munro and McTaggart-Cowan 1947). In 2001, it was estimated that there were approximately 10 000 breeding birds in British Columbia based on extrapolations of male counts at dancing grounds and allowance for annual variability and error. The largest populations occur in the central Interior where the population is estimated to be between 4000 and 8200. In the southern Interior, the population is estimated to be between 600 and 1200.

A review of lek counts in the climax grasslands of the Thompson Okanagan Plateau (WLAP Region 3) from 1986 through 1999 documented a decline in population and number of leks (Leupin and Murphy 2000b). Populations declined by close to 50% from 1990 numbers when populations were at their most recent peak. Of 23 known leks (1986–1988) period, only 43% remained active in 1998. However, it is uncertain whether recently discovered leks in the grasslands are replacements for those abandoned in the past decade.

Lek counts in seral grasslands of Cariboo Basin and Chilcotin Plateau (WLAP Regions 3 and 5) from 1993 through 2000 showed a decline of similar proportions. Counts at seven leks fell from an average of 18 birds/lek in 1993 to 10 birds/lek in 2000 (i.e., 44% decline in numbers). This decline was not unexpected as forest regrowth has invaded open sites even during this relatively short time. However, of eight leks known in 1993 and revisited in 2000, all remained active. New leks are being found each year in clearcuts indicating at least some compensation for the downward trend in numbers observed on leks of the older clearcuts. Overall the limited evidence suggests a decline in numbers of birds in clearcuts since 1993 but it is unlikely that the decline is as severe as that recorded in the climax grasslands.

Habitat trends

Urban and agricultural development and forest encroachment into climax grasslands continue to reduce or degrade the amount of available habitat for the grassland populations. In the northern part of the Columbian Sharp-tailed Grouse range, clearcut logging has increased habitat, although planting and mechanical site preparation techniques may reduce the overall benefit.

Threats

Population threats

Disturbance at leks may cause females to avoid them rendering the leks reproductively inactive (Baydack and Hein 1987). Illegal hunting may threaten isolated populations whose numbers are already depressed by habitat alteration and fragmentation. Predation may keep populations depressed where predator populations are high or birds are predisposed to predation due to poor habitat conditions.

Habitat threats

The main threats include subdivision of ranchlands, heavy livestock grazing, water management, and fire suppression. Some silvicultural and agricultural practices may also act to depress populations.

Subdividing ranches into hobby farms is a growing trend that has already displaced Sharp-tailed Grouse from some of their best grassland habitats. Subdivision means more disturbance by higher numbers of humans and pets. It also brings with it grazing that tends to be heavier than on well-managed rangelands.

Livestock grazing occurs over most of the range of the Columbian Sharp-tailed Grouse. The impact of livestock is most apparent in the grassland habitats where rotational grazing systems often leave little residual grass for nesting Sharp-tailed Grouse on fall and early spring grazed ranges or pastures. Long-term grazing has reduced shrub and tree components of riparian habitats and continues to do so. Those components are vital to the survival of Sharp-tailed Grouse in grassland habitats.

Water storage and diversion may damage riparian vegetation. Damage from fluctuating water levels is most evident at impoundments but storage and diversion of water results in less water downstream for maintaining riparian vegetation. Drainage of wetlands can severely reduce the size of areas supporting scrub birch, water birch, and willow.

Several common silvicultural practices have the potential to reduce populations over the long term:

1. Planting xeric, treeless sites can reduce openness and contributes little to fibre production from the forest.
2. Deep trenching to improve seedling survival may impede movement of chicks, making it difficult for them to forage and increasing their vulnerability to predation in the first few days after leaving the nest.
3. Plantations are often thinned and weeded after establishment removing deciduous species such as willow, aspen, and birch that are winter food sources.
4. Use of insecticides reduces the amount of insects available to chicks during critical early stages of development.

Legal Protection and Habitat Conservation

The Columbian Sharp-tailed Grouse, its nests, and its eggs are protected from direct persecution by the provincial *Wildlife Act*.

This subspecies is hunted over part of its range in British Columbia (Parts of MWLAP Region 5 and management unit 3-31) but season closures are in effect in all grassland habitats of these regions.

Approximately 7000 ha of suitable habitat are within wildlife management areas (WMAs) including Junction, Chilanko Marsh, Dewdrop-Rosseau Creek, and Tranquille WMAs.

A number of protected areas include habitat for Columbian Sharp-tailed Grouse totalling about 32 000 ha. However, some of those overlap WMAs so the total area of habitat protected is probably less than 35 000 ha. Except for their importance as ecological benchmarks, ecological reserves contribute little to the protection of Columbian Sharp-tailed Grouse.

Range use plans under the results based code may address the needs of this species provided management objectives and measures as follows are incorporated into the plans.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain known lek sites in native grassland habitats. The priority for establishing WHAs should be in grassland habitats where populations are most at risk. At this time it is not considered necessary to establish WHAs for populations occurring in clearcuts.

Feature

Establish WHAs at known lek sites in native grasslands.

Size

Typically 700 ha but will vary depending on site-specific factors.

Design

Ideally, the WHA should be at least a 1.5 km radius around the lek but the shape will vary according to site-specific considerations, including nearness of wintering, nesting, and rearing habitats. When present, riparian areas should be included as well as other important habitat features (i.e., deciduous copses, shrub patches and tall grass areas).

General wildlife measure

Goals

1. Minimize disturbance during critical times.
2. Maintain winter food supply.
3. Maintain secure nesting and rearing habitat.
4. Minimize forest encroachment.

Measures

Access

- Permanently deactivate or rehabilitate roads after use. Close roads that pass within 100 m of an active lek during April and May. Consult MWLAP for site-specific times.
- Prohibit access to leks between 1 April and 31 May when females attend the leks for breeding.

Pesticides

- Do not use pesticides.

Range

- Maintain residual grass cover to a minimum height of >25–30 cm in 50% of grass stands. Graze to an average of no greater than 30% use.
- Do not graze during the nesting or early rearing season (i.e., 1 April to 31 May).
- Maintain deciduous shrub and tree components in riparian areas. A maximum removal from livestock grazing of 10% of annual growth of woody vegetation <2 m is recommended.
- Do not hay or mow until after August 15. Maintain residual grass cover to a minimum of 20 cm. Retain shrub cover in meadows surrounding the harvested area.
- Do not place livestock attractants within WHA.
- Do not construct fences or place livestock oilers within 400 m of lek. Fences may be constructed within 400 m if not within line of sight of lek.
- Do not herd large numbers of livestock through the WHA between 15 April to 30 June.

Additional Management Considerations

Water licence applications that would flood, drain, or divert water from known wintering areas for Columbian Sharp-tailed Grouse should not be permitted. Draining of sedge meadow complexes should be prevented.

Protect water supply to water birch and scrub birch stands where Sharp-tailed Grouse winter. Discourage channelling of creeks.

For populations occurring in clearcuts or sedge meadow complexes, consider the following recommendations:

- Maintain natural openings and continued supply of early seral habitat. Consult MWLAP when harvesting near known sites.
- Avoid deep trenching (>20 cm) and other mechanical site preparation that result in deep depressions and loss of deciduous species. Where necessary, patch scarification methods are preferred over disc trenching.
- Retain aspen, birch, and willow when thinning and weeding.
- Maintain deciduous species in riparian areas adjacent to known populations.
- Do not use insecticides in clearcuts used by nesting or rearing Sharp-tailed Grouse.
- Control forest encroachment. Prescribed burning may be used to stimulate shrub production and to prevent forest encroachment.
- Maintain aspen, birch, willow, and deciduous species.
- Minimize haying of scrub birch/sedge meadow complexes.

Information Needs

1. Research on cutblock/sedge meadow complex populations including DNA analysis.
2. Use of prescribed fire in maintaining suitable habitat.
3. Adaptive management to determine which grazing regimes are most appropriate for managing grassland populations of the Columbian Sharp-tailed Grouse.

Cross References

Burrowing Owl, Long-billed Curlew, “Sagebrush” Brewer’s Sparrow

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American White Pelican

Pelecanus erythrorhynchos

Original[1] prepared by William L. Harper

Species Information

Taxonomy

The American White Pelican (*Pelecanus erythrorhynchos*) is one of two species from the family Pelecanidae that occurs in British Columbia; the other is the Brown Pelican (*P. occidentalis*). No subspecies of the American White Pelican are recognized (Evans and Knopf 1993; Cannings 1998).

Description

A very large white bird (150–188 cm in length; wingspan of 240–300 cm), with black wingtips and a long, orange-pink pouched bill (Godfrey 1986). The bill has a conspicuous gular pouch that is used to hold captured fish and sieve them from water. During the breeding season, an upright horny plate grows on the top portion of the culmen. Feet and legs are a bright orange; bare skin found around the eyes is orange and eyelids are red. Adult males and females are similar in appearance; females are noticeably smaller. Immatures are similar to adults; however, feathers are typically more greyish and bill and feet duller.

Distribution

Global

American White Pelicans only occur in North America (Evans and Knopf 1993). They breed from central British Columbia, extreme southwestern Northwest Territories, central Saskatchewan, southern Manitoba, and western Ontario, south locally to California, Nevada, Utah, Wyoming, South Dakota, and southeastern Texas (Godfrey 1986; Evans and Knopf 1993). Their winter range includes California, Arizona, and the Gulf States south through Mexico to Guatemala (Cannings 1998).

British Columbia

Pelicans nest at only one location in British Columbia—Stum Lake, 70 km northwest of Williams Lake. Birds from the Stum Lake colony forage in lakes, rivers, and streams over a broad area of the Fraser Plateau, approximately 30 000 km^2 (Harper and Steciw 2000). Little is known about the size or behaviour of non-breeding pelican populations that occur in British Columbia; however, it is thought that many of them forage within the same area as breeding birds. A substantial population of unknown breeding status forage at Nulki and Tachick lakes, 15 km southwest of Vanderhoof. In the Kootenays, pelicans regularly occur within the Creston Valley Wildlife Management Area south of Kootenay Lake (Gowans and Ohanjanian 2000). Pelicans do not typically winter in British Columbia, although individuals occasionally stay during winter months (Campbell et al. 1990).

Forest region and districts

Coast: Chilliwack, South Island, Sunshine Coast

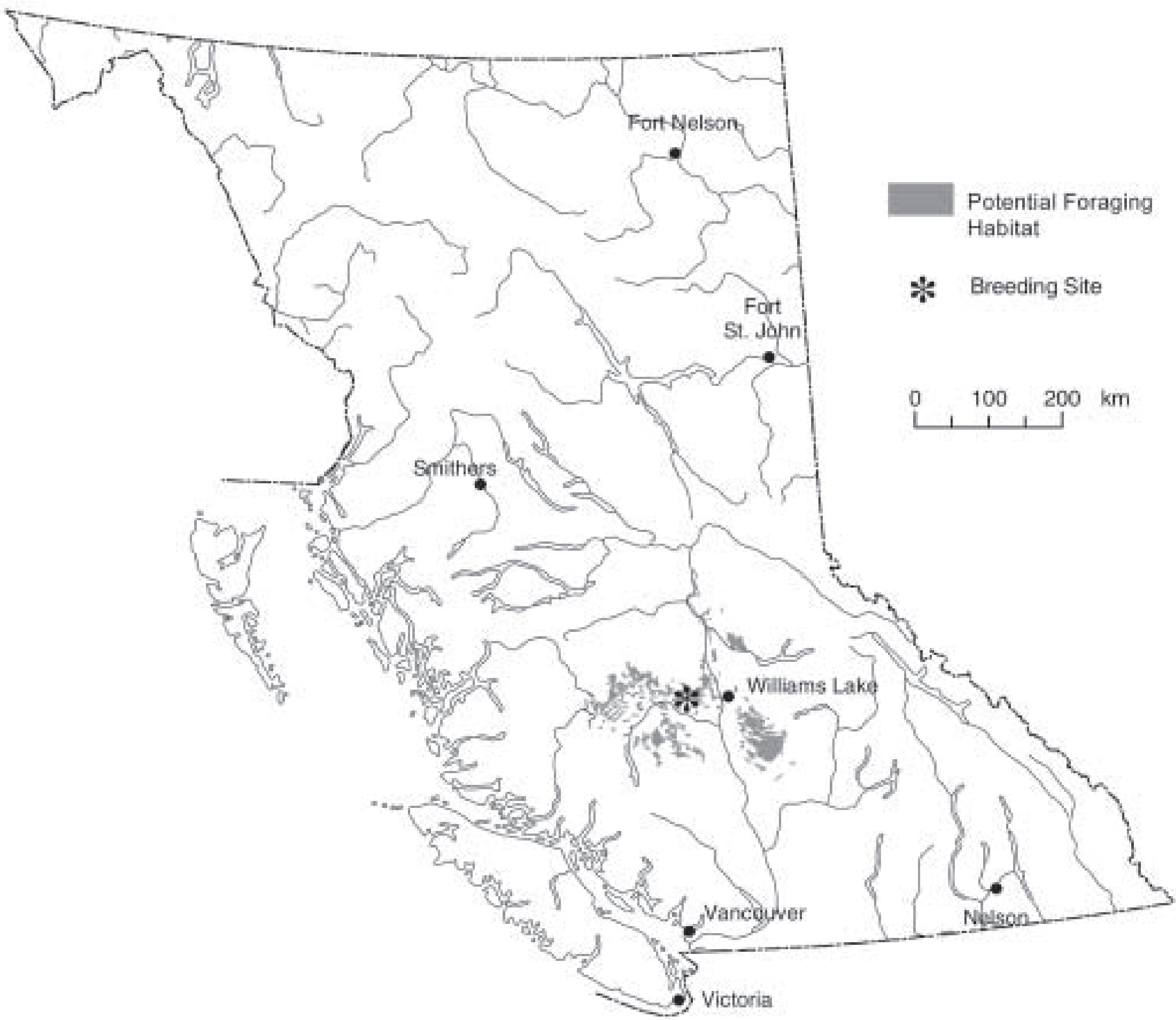
Northern Interior: Fort St. James (substantial population of unknown breeding status), Vanderhoof

Southern Interior: 100 Mile House, Arrow Boundary (non-breeding and migratory), Central Cariboo, Chilcotin (breeding and foraging), Kamloops, Okanagan Shuswap, Quesnel

1 Volume 1 account prepared by R. Dawson.

American White Pelican

(Pelecanus erythrorhychos)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Ecoprovinces and ecosections

CEI: BUB, CAB, CHP, FRB, NAU, QUL, WCU
GED: FRL, GEL, NAL, SGI (migratory), SOG
SBI: BAU
SIM: SFH
SOI: NOB, SOB, STU, THB

Biogeoclimatic units

BG, IDF, SBPS, SBS – all subzones (breeding)
ICH (non-breeding and migratory), PP
CDF (migratory), CWH

Broad ecosystem units

FE, GB, LL, LS, ME, OW

Elevation

Sea level to 1220 m (Campbell et al. 1990)

Life History

Diet and foraging behaviour

American White Pelicans are mainly piscivorous (fish-eating), foraging both singly and in co-operative groups (Johnsgard 1993). Group foraging includes flocks of pelicans driving schools of fish toward shallow water by dipping their bills into the water while slowly swimming forward (Anderson 1991). Pelicans appear to be able to shift feeding strategies to optimize foraging efforts in lakes and streams depending on the availability of prey resources (McMahon and Evans 1992).

Analysis of regurgitates from nestlings showed that minnows (Cyprinidae – *Cyprinus, Gila, Pimephales, Richardsonius, Rhinichthys, Ptychocheilus*) and suckers (Catostomidae – *Catostomus*) dominate the nestling diet at many pelican colonies (reviewed in Harper 1999). Other prey species found include stickleback (Gasterosteidae – *Pungitius, Culaea*), sunfish (Centrarchidae – *Archoplites, Pomoxis*), bullhead (Ictaluridae – *Ameiurus*), perch (Percidae – *Perca, Stizostedion, Etheostoma, Micropterus*), salmon and trout (Salmonidae – *Oncorhynchus*), salamanders (Caudata – *Ambystoma, Necturus*), and crayfish (*Orconectes, Astacus*). Bones from seven fish estimated to be 30–40 cm long were discovered at the Stum Lake breeding colony. These were determined to be from six suckers (*Catastomus* spp.) and one northern squawfish (*Ptychocheilus oregonensis*) (Dunbar 1984).

Pelicans are surface feeders, typically foraging in shallow water near shore, but they are also known to forage in the upper metre of the water column over deeper open waters (Findholt and Anderson 1995). Measurements of bill and neck lengths suggest foraging is restricted to the upper 1.25 m of the water column (Anderson 1991). Fish are typically caught with a rapid dip of the bill, with the gular sac held open in the form of a scoop.

Nocturnal foraging is common during the breeding season, but apparently not in winter (Evans and Knopf 1993). In the daytime, prey is probably located visually. At night, bill contact combined with an increased rate of bill dipping is thought to help locate prey. Besides possible advantages in capturing prey at night, nocturnal foraging allows pelicans to travel during the day to take advantage of rising thermals to save energy while soaring (O'Malley and Evans 1984). Recent studies have confirmed the importance of nocturnal foraging to pelicans in British Columbia (Harper and VanSpall 2001).

Reproduction

American White Pelicans are colonial breeders, with nesting generally synchronized across an entire colony (Baicich and Harrison 1997). Pelican colonies are often mixed with nesting Double-crested Cormorants (*Phalacrocorax auritus*), as is the case at Stum Lake with approximately 13 nesting cormorant pairs (Fraser et al. 1999).

Pelican courtship begins shortly after birds arrive at the nesting island. In British Columbia, nest building is typically initiated within 3–4 days after pelicans arrive at the nesting colony (Campbell et al. 1990). Both adults build the nest over 3–5 days (Baicich and Harrison 1997). Most nests are made from mounds of dirt, sticks, reeds, and debris, although occasionally shallow depressions in sand are used (Campbell et al. 1990).

In British Columbia, clutches are laid between early May and late July, peaking during the second and third weeks of May (Dunbar 1984). Clutch size ranges from one to four eggs, with an average clutch size of 1.95 in years with no disturbance, and 1.69 in years with disturbance (Dunbar 1984). Although two eggs may be laid, only 1% of nests are likely to fledge two young, because the second-hatched chick is killed either directly by the elder sibling or indirectly through starvation (Evans 1996).

Incubation period is 29–36 days and is done by both sexes (Baicich and Harrison 1997). Adults brood young for 15–18 days and are fed mostly a liquefied diet of regurgitated fish matter. Most young in British Columbia are hatched by late June and are fledged by late July to early August (Campbell et al. 1990). Mobile young pelicans form overnight creches (close aggregations of juveniles) beginning at about 17 days of age, after which both parents begin leaving the nest at the same time to forage (Evans 1984). Creching is thought to provide both thermoregulatory (i.e., reduce resting metabolic rate by at least 16% at 10°C) and antipredator advantages to young juveniles (Evans 1984). Young typically fledge at 7–10 weeks of age (Baicich and Harrison 1997).

Site fidelity

American White Pelicans exhibit a very strong fidelity to breeding sites, returning to the same nesting islands annually (Evans and Knopf 1993). Human or natural disturbance at nesting colonies during the previous year typically does not deter birds from returning the following year. Only catastrophic disturbance (e.g., island flooding, desecration, or destruction) will cause pelicans to abandon a nesting area. However, under such circumstances, pelicans generally establish a new nesting colony close to the original site. It is believed that pelicans breed every year at Stum Lake, although the location of the colony was not identified until 1939 (Munro 1945).

Home range

American White Pelicans have large home ranges. Pelicans are highly mobile (up to 50 km/hr) and efficient flyers allowing them to shift foraging sites to take advantage of temporarily abundant food supplies (Evans and Knopf 1993). Pelicans routinely fly 50–100 km from their nesting islands to feed at outlying foraging lakes (Johnson and Sloan 1978; Evans and Knopf 1993; Derby and Lovvorn 1997).

In British Columbia, aerial surveys have documented pelican foraging lakes as far as 165 km (Abuntlet Lake) from the nesting colony (Wood 1990). Pelicans from Stum Lake forage at 40 different lakes over an area of 30 000 km^2 on the Fraser Plateau (Wood 1990; Harper and Steciw 2000; Harper and VanSpall 2001). A significant population of adult pelicans also occur approximately 200 km north of the nesting colony at Nulki, Tachick, and Stuart lakes, but the breeding status of these birds is unknown at this time (Harper and VanSpall 2001). Large numbers of non-breeding pelicans are also present throughout the summer in the Creston Valley Wildlife Management Area south of Kootenay Lake (Gowans and Ohanjanian 2000).

Movements and dispersal

American White Pelicans are highly migratory. Most pelicans arrive on the Fraser Plateau in mid-April; earliest arrival 10 March (Campbell et al. 1990). Pelicans leave for their wintering grounds in California and Mexico from September to mid-October (Dunbar 1984; Campbell et al. 1990). It is thought that Stum Lake pelicans migrate west of the Rocky Mountains towards the southwestern United States (Campbell et al. 1990). Pelicans banded at Stum Lake have been recovered in Washington, Oregon, Idaho, Utah, California, and Mexico (J. Young, pers. comm.).

Habitat

Structural stage

1a: sparse (nesting and loafing)
2a: forb-dominated herb (nesting and loafing)
2b: graminoid-dominated herb (nesting and loafing)
2c: aquatic herb (loafing)

Important habitats and habitat features

In general, American White Pelicans require undisturbed islands for nesting and isolated lakes with adequate prey fish species for foraging.

Nesting

Nests are built on islands in lakes with little natural or human disturbance (Evans and Knopf 1993). Nesting islands are typically flat, with little vegetation or large ground debris present due to physical disturbance by pelicans and high soil acidity from guano. Prey fish populations are not necessarily present at nesting lakes, but stable water levels are important to maintain productive nesting habitats. Rising water levels can result in flooding of nest sites, and falling water levels can reduce the effectiveness of the water barrier that is used as security from terrestrial predators.

The only breeding colony in British Columbia is located at Stum Lake on the Fraser Plateau, a shallow (mean depth of 2.5 m), slightly alkaline (pH = 8.6), 900 ha lake at 1220 m elevation (Campbell et al. 1990). Nesting occurs at variable levels on four different islands at Stum Lake (Dunbar 1984; Campbell et al. 1990; Harper and Steciw 2000). Three of the four islands are non-forested and very sparsely vegetated, but one contains well-spaced spruce and birch trees. These nesting islands are located 80–600 m from shore, are low in profile (up to 6.7 m in height), and range in size from 90 to 1000 m^2. Nests are generally closely spaced and situated on flat areas, often adjacent to dead trees, logs, and rocks (Dunbar 1984). Most nests are made from mounds of dirt, sticks, reeds, and debris, although occasionally shallow depressions in sand are used (Campbell et al. 1990). The nests are loosely lined with feathers, twigs, fish bones, or small stones.

Foraging

American White Pelicans forage in slow-moving streams and rivers, lakes, permanent or semi-permanent marshes, reservoirs, and, to a limited extent during migration, coastal bays, estuaries, and near-shore marine sites (Johnsgard 1993). Pelicans are opportunistic in their food habits, and prey species vary greatly depending on location and time of year. Foraging waters range from nutrient-rich to nutrient-poor, muddy to clear, with various shorelines of mud, sand, gravel, and rock (Evans and Knopf 1993). There is less site tenacity than for breeding habitats; however, birds return to the same foraging lakes when prey species are present.

In British Columbia, pelicans forage in shallows along the shorelines of lakes, at creek mouths, in shallow open water in the middle of lakes, and in streams (Dunbar 1984; Harper and VanSpall 2001). Stream foraging, which was only observed in the spring, is thought to be associated with the spawning activities of coarse fish such as longnose suckers (*Catostomus catostomus*). Inlets and outlet streams are a significant component of pelican foraging habitat, not only because their deltas are often used as loafing habitat, but also because these streams provide foraging opportunities, particularly when fish are spawning.

In British Columbia, the average elevation of 19 main foraging lakes is 1004 m above sea level (Harper and Steciw 2000). Puntzi Lake is the largest of these foraging lakes with a surface area of 1706 ha. The other foraging lakes are much smaller, and are relatively similar in size, averaging 321 ha in surface area, 4 m in depth, and 15 million m^3 in volume (Harper and Steciw 2000). Most of these lakes are fairly alkaline in nature with 8 of 11 having pH readings from 8.5 to 9.2.

Loafing areas are important as stopovers for flights from foraging lakes to the nesting colony where pelicans rest, preen, and wait for favourable flight conditions. In British Columbia, the most commonly used loafing sites are sandbars and mud flat islands at the deltas of major inlets and floating vegetation along the marshy edges of shallow lakes (Harper and Steciw 2000). Deadfall, partly submerged logs, and shorelines are also used for loafing (Wood 1990).

Conservation and Management

Status

The American White Pelican is on the provincial *Red List* in British Columbia. It is designated as *Not at Risk* in Canada (down-listed from *Threatened* in 1987 (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	NWT	WA	ID	MT	Canada	Global
S1B, SZN	S2B	S?	S1B, SZN	S1B, SZN	S2B, SZN	N4B	G3

Trends

Population trends

The global population of American White Pelicans is estimated at approximately 52 000 breeding pairs (Johnsgard 1993). There are 50 breeding colonies in western Canada and 18 in the United States, many of which are threatened by loss of habitat and water level problems (Evans and Knopf 1993). In British Columbia, the one nesting colony at Stum Lake has been censused numerous times beginning in 1953. Counts of nests have ranged from a low of 85 nests in 1968 to a high of 423 nests in 1993 (Dunbar 1984; J. Steciw, pers. comm.). Nest counts at Stum Lake averaged 285 nests between 1997 and 2001 (J. Steciw, pers. comm.). Although population fluctuations are common, the American White Pelican breeding population in British Columbia is considered stable. Non-breeding birds in the Creston Valley Wildlife Management Area in the Kootenays have increased from a few birds in the 1980s to maximum count of 83 in 1999 (Gowans and Ohanjanian 2000). Birds of unknown breeding status at Nulki and Tachick lakes have increased from a few birds in the early 1990s to a maximum count of 77 in 2000 (Harper and VanSpall 2001).

Habitat trends

Habitats in and around the breeding colony are protected within White Pelican Provincial Park. Trends in foraging habitat quality are linked to rates of development and access to foraging lakes. Most foraging lakes are being impacted at various levels by increasing human use, including road development; lakeshore development for recreational use; boating; changes in lake water levels associated with irrigation use; and changes in fish stocks associated with introduction of game fish.

Threats

Population threats

The negative impacts of disturbance at breeding colonies are severe and well known (Dunbar 1984; Evans and Knopf 1993). Human disturbance can cause predation of eggs and chicks, nest abandonment, cooling or overheating and dehydration of eggs and chicks, accidental crushing of eggs by adults, trampling, and undue stress and regurgitation of foods (Hall 1926; Bunnell et al. 1981; Bowman et al. 1994). The timing of these disturbances is critical. Disturbance by coyotes (*Canis latrans*) or humans early in the nesting period can cause sudden and complete desertion of the nesting colony (Bunnell et al. 1981; Evans and Knopf 1993). Low flying aircraft over the Stum Lake breeding colony are known to have caused high levels of disturbance and offspring mortality (Bunnell et al. 1981; Dunbar 1984). Although causes are unknown, complete abandonment of the Stum Lake colony has been documented three times in the past 41 years: in 1960 (Dunbar 1984), 1986 (Campbell et al. 1990), and 2001 (J. Anderson, pers. comm.).

The level of tolerance at foraging sites to human disturbance is less well known. Human activities that are known to cause disturbance to pelicans at foraging areas include recreational boating; angling; water skiing; backcountry use and lakeshore activities, such as hiking and camping; vehicle traffic; and forest harvesting (Hooper and Cooper 1997; Harper and Steciw 2000). Wood (1990) found foraging pelicans responded to disturbance (human presence, motorboats, aircraft) by flying to another area of the lake or leaving the lake entirely. Pelican responses to different levels of human disturbance can vary greatly (Evans and Knopf 1993). In British Columbia, experimental approaches by researchers elicited various reactions by pelicans, with some birds flying away when approached within 300 m, while others only swam away when approached to 50 m (Harper and VanSpall 2001). The greatest potential impact of human disturbance away from the breeding colony may be at loafing and roosting sites.

Habitat threats

The primary threat to American White Pelicans in British Columbia is the potential destruction and alteration of their nesting habitat (Hooper and Cooper 1997; Harper and Steciw 2000). Although the breeding colony is protected in the Class A White Pelican Provincial Park, stabilizing water levels at Stum Lake is still important to maintain the productivity of the nesting islands. If water levels are too high, then nesting islands are inundated and the nests are flooded. If water levels are too low, then nesting islands become connected to the mainland and lose their ability to act as a barrier to mammalian predators.

Alteration of foraging habitats is major potential threat to American White Pelicans (Hooper and Cooper 1997; Harper and Steciw 2000). Legal and illegal alterations of stream courses and damming of streams affect foraging lake water levels and fish abundance. Streams and lakes are often dammed for irrigation or drained to create more agricultural land (Hooper and Cooper 1997). For example, the Chilcotin River inlet to Chilcotin Lake was illegally diverted in 1975 (Harper and Steciw 2000). In the late 1980s, a number of dams constructed in the Rosita–Tautri Lakes chain altered lake levels and potentially served as barriers to the migration and spawning of Longnose Suckers, a principal prey species for pelicans. As with nesting islands, water levels can affect pelican loafing and roosting habitat. Abnormally high water levels can flood mudflat islands and low water levels cause loafing habitats to become connected to the mainland and lose their ability to provide protection from potential predators (Hooper and Cooper 1997; Harper and Steciw 2000).

American White Pelicans in British Columbia could also be affected indirectly by negative impacts to fish prey species in foraging lakes (Hooper and Cooper 1997; Harper and Steciw 2000). Pollution from motorboats, chemical runoff from agricultural lands, and rural sewage could potentially inhibit reproduction or cause mortality fish prey species (Hooper and Cooper 1997). The introduction of game fish in foraging lakes could also potentially reduce fish prey species due to competition for food resources and/or direct predation (Evans and Knopf 1993).

Legal Protection and Habitat Conservation

The American White Pelican, its nests, and eggs are protected from direct persecution in British Columbia by the provincial *Wildlife Act*. It is also designated *Endangered* under the provincial *Wildlife Act*.

Stum Lake and the breeding colony have been protected within White Pelican Provincial Park, a Class A park of 2763 ha, since 1971 (Bunnell et al. 1981; Fraser et al. 1999). To protect nesting pelicans, the park is closed to the boating, angling, landing of floatplanes, and the discharge of firearms from 1 March to 31 August (Dunbar 1984). Transport Canada regulations restrict aircraft over Stum Lake to altitudes above 610 m (Bunnell et al. 1981).

Nazko Lakes Provincial Park (15 548 ha) and Kluskoil Lake Provincial Park (12 419 ha) are both Class A wilderness parks that encompass foraging habitat of American White Pelicans. Established in 1995, these parks effectively protect some foraging habitat values. However, unlike White Pelican Provincial Park, they are not managed exclusively for pelicans, so there is the potential that park status could lead to increased human use and higher levels of disturbance for foraging pelicans.

The Cariboo-Chilcotin Land-Use Plan (CCLUP) (Province of British Columbia 1995) generally addresses the issue of public access to pelican foraging habitats with the direction that, "where required, roads will be planned to limit impacts on environmental values and road closure and deactivation and rehabilitation requirements for existing and future roads will be specified." This plan identifies important foraging lakes and also directs resource managers to "provide buffers of at least 200 m and limit human disturbance around important pelican feeding lakes" (Province of British Columbia 1995).

Under the results based code, conservation of riparian forest edges at foraging lakes and streams may be partially addressed through application of riparian and lakeshore guidelines.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

The quality of pelican foraging habitats can be greatly affected by the level of public access, through negative impacts caused by human disturbance and introduction of pollutants. Establishing WHAs, riparian reserves, and lakeshore management zones around these habitats may not be entirely adequate for addressing these concerns. Access management must be given particular attention in forest development plans to ensure that the construction and deactivation of roads near pelican habitats is conducted in accordance with strategic planning objectives.

- ❖ Access objectives should be identified for each pelican foraging lake, beginning with provisions in the Cariboo-Chilcotin Land-Use Plan (Province of British Columbia 1995) and other applicable strategic or landscape-level plans. Objectives under the Recreational Opportunity Spectrum (ROS) as laid out in the Ministry of Forests' Recreation Inventory can serve to describe these access management objectives (MOF and MELP 1996a).
- ❖ As much as possible, important foraging lakes should be classified as *wilderness lakes* (having a primitive ROS objective and allowing no roads within 8 km). Other pelican foraging lakes should be classified as *quality lakes* (having a semi-primitive non-motorized ROS objective and allowing no roads within 1 km) (MOF and MELP 1996a, 1996b). Access management must then be planned to meet those objectives, addressing proximity of roads and road quality, road deactivation, trails to lakes, boating restrictions, aircraft restrictions, and recreation sites.

Wildlife habitat area

Goal

Protect foraging, loafing, and roosting habitat from human disturbance and habitat loss or alteration.

Feature

Establish WHAs on foraging, loafing and roosting sites on and adjacent to lakes, stream reaches, and other aquatic habitats used by American White Pelicans during the breeding season. WHAs should not normally be established on aquatic habitats used only during spring and fall migration unless there are compelling conservation reasons, such as the regular and predictable use of critical staging areas.

Size

Typically, 1 km around the entire aquatic area of lakes and stream reaches used for foraging, loafing, or roosting by pelicans.

Design

The WHA should include a core area and a management zone. The core area should be the reserve area designated by the CCLUP, riparian or lakeshore management guidelines under the *Forest and Range Practices Act*.

The WHA should include the lake or stream reach used for foraging, and all aquatic and riparian areas used for loafing and roosting. Maximize the size of the WHA adjacent to known foraging areas, and loafing and roost sites to maintain the quality and isolation of these habitats.

General wildlife measures

Goals

1. Maintain the isolation of foraging lakes and stream reaches, and loafing and roosting sites.
2. Minimize disturbance during the breeding season (1 April to 15 September).
3. Maintain integrity of habitats of prey species.

Measures

Access

- Do not develop any new permanent roads (e.g., forest service or main haul). Ensure temporary roads (e.g., road sections off main roads) are made impassable to vehicles from 1 April to 31 August.

Harvesting and silviculture

- Do not harvest in the core area.
- Within the management zone, do not harvest, including salvage, during breeding season (1 April–15 September).
- Maintain riparian reserves on all lakes and wetlands within WHA using the largest reserve areas as described in the *Riparian Management Area Guidebook*. Maintain riparian reserves on all streams within the WHA according to stream size as described within the *Riparian Management Area Guidebook*.
- Do not use motorized manual or heavy equipment for site preparation or other silvicultural work from 1 April to 31 August.
- Minimize vehicle use during silvicultural and other work from 1 April to 31 August.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreation sites.

Additional Management Considerations

Disturbance of pelicans at their feeding sites can have negative consequences for breeding success. Foraging lakes that do not have permanent road access should be maintained that way by routing any new permanent roads well away from foraging habitats used by pelicans. Floatplanes should not land or fly low over pelican foraging lakes. Operations that involve a lot of human activity (e.g., logging camps, landings) should be located as far away from WHAs as possible. Activities that alter the natural condition of feeding lakes or encourage recreational use (e.g., stocking with recreational fish, use that causes fluctuations in water levels during the breeding season, alienation of Crown land along the perimeter of feeding lakes) should be discouraged.

Draft guidelines, available for commercial recreation tenures in British Columbia, provide conservation objectives for the American White Pelican (see MELP 2000).

Information Needs

1. Specific locations of important stream and river reaches that are used at night by foraging pelicans.
2. Specific locations of loafing and roosting sites for some foraging lakes.
3. Impacts of various levels of disturbance at foraging, loafing, and roosting areas.

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Sandhill Crane

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Great Blue Heron

Ardea herodias

Original[1] prepared by Ross G. Vennesland

Species Information

Taxonomy

Three subspecies of the Great Blue Heron are recognized in North America, two of which occur in British Columbia: *A. herodias herodias*, which occurs across most of North America, and *A. herodias fannini*, which occurs only on the Pacific coast from Washington to Alaska (Payne 1979; Hancock and Kushlan 1984; Cannings 1998). The separation of these subspecies is based on differences in plumage, morphology, and migratory behaviour (Hancock and Elliott 1978; Payne 1979).

Description

The Great Blue Heron is the largest wading bird in North America, and measures about 60 cm in height, 97–137 cm in length, and 2.1–2.5 kg in mass (Butler 1992). The wings are long and rounded, the bill is long, and the tail is short (Butler 1992). Great Blue Herons fly with deep, slow wingbeats and with their necks folded in an S-shape. Plumage is mostly a blue-grey colour and adults have a white crown.

Distribution

Global

Great Blue Herons breed in three distinct regions of North America. *Ardea herodias occidentalis* breeds in Florida, *A. herodias fannini* breeds on the Pacific coast from Washington to Alaska, and *A. herodias herodias* breeds from southern Canada south to Central America and the Galapagos (Butler 1992). Populations of *A. herodias fannini* are non-migratory (Butler 1992). Winter ranges for *A. herodias herodias* include the Pacific coast of North America, the continental United States, Central America, and northern South America to Colombia, Venezuela, and the Galapagos (Butler 1992).

British Columbia

In British Columbia, *A. herodias fannini* occurs year-round on the Pacific Coast and occasionally inland to the Bulkley Valley (Campbell et al. 1990; Gebauer and Moul 2001), and *A. herodias herodias* occurs in southern interior regions of the province primarily during breeding and migratory periods (Campbell et al. 1990; Cannings 1998). The highest concentrations of breeding herons occur in the Georgia Depression ecoprovince due to the presence of several large colonies (Campbell et al. 1990; Gebauer and Moul 2001).

Forest regions and districts

The *A. herodias fannini* subspecies occurs in the Coast Forest Region and the *A. herodias herodias* subspecies occurs in the Southern and Northern Interior forest regions.

Coast: Campbell River*,[2] Chilliwack*, North Coast*, North Island, Queen Charlotte Islands*, South Island*, Squamish*, Sunshine Coast*

Northern Interior: Kalum, Nadina, Peace, Prince George, Skeena Stikine, Vanderhoof

Southern Interior: 100 Mile House*, Arrow Boundary*, Cascades*, Central Cariboo*, Chilcotin, Columbia*, Headwaters*, Kamloops*, Kootenay Lake*, Okanagan Shuswap*, Quesnel*, Rocky Mountain*

1 Draft Vol. 1 account prepared by Ken Summers.
2 * = known to breed.

Great Blue Heron
(Ardea herodias)

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, and Biogeoclimatic) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Ecoprovinces and ecosections

BOP: PEL, HAP

CEI: BUB, CAB*, CAP*, CHP, FRB, NAU, NEU

COM: CPR, CRU, EPR*, HEL*, KIM, KIR, MEM, NAM, NCF, NIM, NPR, NWC*, NWL, OUF, QCL*, QCT, SBR, SKP*, SPR*, WIM*, WQC*

GED: FRL*, GEL*, LIM*, NAL*, SGI*, SOG*

SBI: BAU, BUB, NEL, NSM, SSM

SIM: BBT, CAM, CCM*, EKT*, EPM, MCR, NPK, SCM*, SFH*, SHH*, SPK*, SPM*, UCV*, UFT

SOI: GUU*, LPR, NIB*, NOB*, NOH*, NTU*, OKR, PAR, SCR, SHB*, SOB*, SOH, STU*, THB, TRU*

Biogeoclimatic units

BG: xh1, xw1

CDF: mm

CWH: dm, ms1, ms2, vh1, vh2, vm1, vm2, wh1, xm

ICH: dw, mk1, mk2, mk3, mw2, mw3, xw

IDF: dk3, dm2, mw1, mw2, un, xh1, xh2

MS: dk

PP: dh2, xh1, xh2

SBS: dk or dh, dw1

Broad ecosystem units

CB, CF, CR, ES, IM, PR, RR, SP, SR, WL, (UR in GED ecoprovince)

Elevation

In British Columbia, most herons occur near sea level on the coast or in the lowlands and valley bottoms of the Interior, though nesting and occurrences have been documented to 1100 m (Campbell et al. 1990).

Life history

Diet and foraging behaviour

Great Blue Herons are prey generalists, although they primarily forage for fish. They stalk prey by walking or standing in shallow water along the shoreline of oceans, marshes, lakes, and rivers and in fields or other vegetated areas (Butler 1992). In upland areas they stalk mostly small mammals such as rodents (Butler 1992). This upland foraging behaviour is more common in winter and for juveniles learning to hunt (Butler 1991). Other prey types include amphibians, reptiles, invertebrates, and birds (Butler 1992). Prey is located by sight and is caught by a rapid thrust of the neck and head (Butler 1992). Herons generally swallow their prey whole (Butler 1992). See Gebauer and Moul (2001) for a more exhaustive review of diet and foraging behaviour.

Reproduction

Great Blue Herons nest throughout the southern Interior and coastal areas of the province, but breeding is concentrated in the Strait of Georgia where several colonies of >100 breeding pairs occur (Eissinger 1996; Butler 1997). It has been estimated that about 84% of the *A. herodias fannini* population and about 65% of all Great Blue Herons in the province breed in this area (Butler 1997; Gebauer and Moul 2001). Large colonies are associated with extensive estuarine mudflats and eelgrass beds around the Fraser River delta (Butler 1993; Eissinger 1996). Colony size has been associated with available foraging area for the Great Blue Heron (Gibbs 1991; Butler 1992; Gibbs and Kinkel 1997).

Breeding is initiated between February and April for *A. herodias fannini* and in late March for *A. herodias herodias* (Butler 1992; Gebauer and Moul 2001). Males arrive at the colony site and establish territories, followed about 1 week later by the females (Butler 1991). Courtship and nest repair and/or building take from several days to about a month (Butler 1991). Monogamous pairs are established for the season (Simpson 1984), and an average of four eggs is laid at about 2-day intervals (Vermeer 1969; Pratt 1970). Clutch size ranges from one to eight, with three to five being typical (Ehrlich et al. 1988; Campbell et al. 1990). Incubation begins soon after the first egg is laid, resulting in asynchronous hatching (Butler 1992). Hatching occurs after about 27 days of incubation (Butler 1992). Young are reared on the nest for about 60 days, fed mostly fish caught near the colony site (Krebs 1974; Simpson 1984). One breeding cycle requires about 100 days, and herons reproduce for about 200 days around the

Strait of Georgia. Thus, herons can potentially breed more than once if their first attempt fails. Breeding duration for the Interior is not known. Heron breeding sites can be relocated rapidly because nests can be built in 3 days (Butler 1997) and eggs can be laid within about 1 week (Butler 1997).

Great Blue Herons first breed after their second winter (Pratt 1973). Estimates of mortality from band recovery data (outside of British Columbia) range from 69% for first year juveniles, 36.3% for second year juveniles, and 21.9%/yr thereafter (Henney 1972, cited by Butler 1992).

Site fidelity

Colonies are dynamic, especially in areas of high disturbance (Butler 1992; Vennesland 2000). Some colonies are used for many years (e.g., Shoal Island, Point Roberts, and Stanley Park, all about 28 years), but most colonies, especially those under 50 nests, are relocated more frequently (Gebauer and Moul 2001). Across British Columbia, it is not clear how frequently the same individuals return to the same nest site. However, at one colony on the Sunshine Coast, Simpson et al. (1987) found that 40% of the breeding herons in 1978 did not return in 1979, and most breeding herons were on different nests and with different mates in 1979. Once a colony has been abandoned for more than 1 year, recolonization occurs infrequently (Gebauer and Moul 2001).

Home range

In British Columbia, breeding colonies range in size from two to about 400 nests with some pairs nesting solitarily (Gebauer and Moul 2001). In south-coastal British Columbia in 1999, Vennesland (2000) reported a mean colony size of 62 nests (SD = 94, $n = 31$), a median of 26 nests, and that the "typical" heron nested in a colony of 199 nests. Large colonies in deciduous trees or small and dispersed colonies can encompass several hectares (R.G. Vennesland, pers. obs.; M. Chutter, pers. comm.). In southern British Columbia, Machmer and Steeger (2002) reported a mean colony size of 19 nests (SE = 6, $n = 7$) and a range of 1–77 nests. During the breeding season, adult herons range within about 30 km of their colonies, although most stay within 10 km (Butler 1991, 1997). During winter, some adults maintain small foraging territories (Butler 1991), but little is known of how frequently alternate sites are used.

Movements and dispersal

Little is known of the initial dispersal of Great Blue Herons from their natal site, but band recoveries suggest that most fledglings disperse from their natal areas (Henney 1972, cited by Butler 1992). Juveniles are believed to disperse widely, often northwards during the summer after fledging. Long distance dispersal of juveniles has been reported. Campbell et al. (1972, cited by Campbell et al. 1990) reported juvenile dispersal from Vancouver to the Fraser Lowlands, Washington State, Oregon State, and Kamloops. On the coast of British Columbia, *A. herodias fannini* is primarily non-migratory, with most birds wintering close to breeding areas (Butler 1997; Gebauer and Moul 2001). In contrast, *A. herodias herodias,* in the interior of the province, is primarily migratory, although the extent of southward movement is unknown. Groups of *A. herodias herodias* are known to overwinter along ice-free watercourses of southern British Columbia (Machmer 2002), but some birds migrate as far south as Mexico and South America (Campbell et al. 1990; Butler 1992).

Habitat

Structural stage (breeding)

5: young forest
6: mature forest
7: old forest

Important habitats and habitat features

Foraging

Great Blue Herons require abundant and accessible prey within 10 km of a breeding location (Butler 1995). Important foraging habitats include aquatic areas such as tidal mudflats, riverbanks, lakeshores, and wetlands (Butler 1992). Shallow water fish species are the most important prey group for herons during breeding and non-breeding seasons (Butler 1992). During winter on the coast, when aquatic prey are less abundant due to a reduced duration of daytime low tides, fallow agricultural fields become important foraging areas for adult and juvenile herons (Butler 1992; Gebauer and Moul 2001). Inland fields are considered an important foraging habitat for both adults and juveniles in the lower Fraser Valley and on southern Vancouver Island (Gebauer and Moul 2001). The number of herons that use non-aquatic foraging habitats is not known, but large numbers of herons reside in south-coastal areas—an estimated 3326 herons (Gebauer and Moul 2001)—so it is likely that these areas are an important foraging habitat for a significant portion of the heron populations in this area. The importance of non-aquatic foraging habitat for herons in the Interior and on other areas of the coast is not known.

Nesting

Colonies occur in relatively contiguous forest, fragmented forest, and solitary trees (Butler 1997). Nests are generally located close together, although highly dispersed colonies have been reported (Vennesland, pers. obs.; M. Chutter, pers. comm.). The most common tree species used for breeding on the coast are red alder (*Alnus rubra*), black cottonwood (*Populus balsamifera*), bigleaf maple (*Acer macrophyllum*), lodgepole pine (*Pinus contorta*), Sitka spruce (*Picea sitchensis*) and Douglas-fir (*Pseudotsuga menziesii*) (Gebauer and Moul 2001). In the southeastern interior, black cottonwood comprises 54% of nest trees with coniferous species —Douglas-fir, western white pine (*Pinus monticola*), hybrid white spruce (*Picea glauca* × *engelmannii*), ponderosa pine (*Pinus ponderosa*), western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*)—accounting for the remaining 46% (Machmer and Steeger 2002). Nest in coniferous trees are more difficult to detect, even during aerial surveys. See Gebauer and Moul (2001) for a more exhaustive review of tree species utilized.

The size of Great Blue Heron populations has been correlated with the area of foraging habitat available locally (Butler 1993; Gibbs and Kinkel 1997). It is therefore important, especially in highly urbanized areas such as Vancouver and Kelowna, that sufficient nesting habitat is maintained near important feeding areas (Butler 1997). In addition, since herons frequently relocate colonies, it is also important that alternate forested sites be available. The very large colonies (~200–400 breeding pairs) that occur around the lower Fraser Valley rely on large parcels of primarily deciduous (mostly red alder) forest. Eagle activity is likely increasing at these sites, making the availability of this type of forest important for reducing the potential impact of foraging eagles by giving herons alternate nesting locations if eagle activity becomes too high at traditional sites (Vennesland 2000).

Conservation and Management

Status

Both subspecies of the Great Blue Heron are on the provincial *Blue List* in British Columbia. In Canada, the *fannini* subspecies is considered a species of *Special Concern* (COSEWIC 2002). The status of the *herodias* subspecies has not been assessed.

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

Subspecies	BC	AB	AK	ID	MT	OR	WA	Canada	Global
A. h. fannini	S3B, S5N	–	S4	–	–	–	?	N?	G5T4
A. h. herodias	S3B, S5N	S3B, S1N	–	S5B, S5N	S4B, SZN	S4	S4S5	N5B, NZN	G5T5

Trends

Population trends

Population size has been difficult to estimate for this species because colonies are not stable entities and are difficult to track in a standardized fashion (Butler 1997; Vennesland 2000; Gebauer and Moul 2001). The *fannini* subspecies in British Columbia is currently estimated at 3626 breeding adults, with an estimated 3326 adults breeding in the Strait of Georgia and 300 breeding elsewhere on the coast (Butler 1997; Gebauer and Moul 2001). The size of the *herodias* subspecies in British Columbia is not known, but probably ranges between 300 and 700 individuals (Gebauer and Moul 2001).

Population trends are also difficult to estimate. Few data are available on the coast prior to the past 30 years; however, over this period the population has been reported to be generally stable or declining. Gebauer and Moul (2001) reported that the Great Blue Heron population on the coast had apparently not changed significantly since Butler (1997) estimated the heron population from data collected from 1987 to 1992, although some measures showed declines (Gebauer and Moul 2001). An annual decline rate of 5.7% was reported from Breeding Bird Survey (BBS) data from 1966 to 1994 (Downes and Collins 1996), but Christmas Bird Counts (CBC) showed populations to be generally stable (Gebauer and Moul 2001). An exception is the Sunshine Coast area, where CBC data indicate a decline from 1991 to 1997. In addition, the number of herons observed breeding on the Sunshine Coast dropped from 97 in 1978 (Forbes et al. 1985b) to 11 in 1999 (Vennesland 2000). Campbell et al. (2001) concluded that coastal Great Blue Herons were the most at risk out of 28 species of birds in British Columbia that showed significant declines based on BBS data. It is generally believed that the size of the Great Blue Heron population in the Interior has increased over the past century, but little information is available on the magnitude of this increase (Gebauer and Moul 2001). Seventeen active breeding sites with 259 active heron nests were detected during a 2002 breeding inventory of the Columbia Basin in British Columbia (Machmer and Steeger 2002). This compares to 10 active sites with 266 active nests in a 1982 survey of a smaller portion of the basin (Forbes et al. 1985a); differences in survey methods and survey area size limit conclusions regarding population trends.

Habitat trends

Suitable nesting habitat has undoubtedly declined in British Columbia over the past century due to increases in the size of human populations and industry, especially in south-coastal areas around the Fraser River delta and Vancouver Island (Moore 1990; Butler 1997; Campbell et al. 2001). The availability of suitable forested lands in British Columbia continues to decrease (Butler 1997; Gebauer and Moul 2001). Habitat destruction in south coastal British Columbia has resulted in the abandonment of at least three colonies (Gebauer 1995; Vennesland 2000). Similarly, the construction of dams, flooding or reservoirs, and the development of forest and riparian lands is associated with some heron colony abandonment in the Interior (Machmer and Steeger 2002).

Suitable foraging habitat is also likely declining in British Columbia, and this decline is considered to be as or more important than that of breeding habitat (Gebauer and Moul 2001). The size of Great Blue Heron populations is correlated with the area of foraging habitat available locally, and consequently the largest concentrations of herons occur around the Fraser River delta where extensive mudflats and eelgrass beds provide abundant foraging locations (Butler 1993; Eissinger 1996; Gibbs and Kinkel 1997). Local declines in foraging habitat have likely been greatest in south-coastal British Columbia because most of the province's human population is located in this area (Butler 1997; Gebauer and Moul 2001).

Threats

Population threats

Direct threats to Great Blue Heron populations in British Columbia include disturbance and mortality from predators and humans, food supply limitations, contamination, and weather.

Vennesland (2000) reported that Bald Eagle (*Haliaeetos leucocephalus*) depredation and human disturbance were the most important direct threats to heron populations because of reductions in breeding productivity. During the 1998 and 1999 breeding seasons, eagles were likely involved in 13 of 14 colony abandonments observed, and eagle depredation of eggs and nestlings had a significant negative impact on the breeding productivity of colonies in south coastal British Columbia (Vennesland 2000). Over the same period, human disturbance was likely involved in one colony abandonment (Vennesland 2000). Other authors have also commented on the potential problems associated with eagles and humans (e.g., Parnell et al. 1988; Norman et al. 1989; Butler et al. 1995; Butler and Vennesland 2000; Gebauer and Moul 2001). Human disturbance has been implicated in many historical colony abandonments in British Columbia (Kelsall and Simpson 1979; Forbes et al. 1985a). Additionally, both these sources of disturbance are increasing in British Columbia (Vermeer et al. 1989; Blood and Anweiller 1994), and their impact on breeding herons is also probably increasing (Vennesland 2000). The killing of adult herons who feed on farmed fish stocks is currently prohibited due to the large influence that the removal of breeding adults can have on local heron populations (Butler and Baudin 2000; R.W. Butler, pers. comm.), although the regional manager of Environmental Stewardship, in consultation with the Canadian Wildlife Service, can issue a permit to kill herons at fish farms. Eagles also attack and kill adult herons (Forbes 1987; Sprague et al. 2002). In addition, although herons commonly nest in urban areas (Butler 1997; Vennesland 2000), disturbance from humans can cause herons to temporarily abandon their breeding attempts, allowing predators to take eggs (Moul 1990). High levels of human activity near breeding colonies have also been linked with increased disturbance from eagles (Vennesland 2000). There have been no reports of direct negative effects on breeding or non-breeding herons from cattle or other agricultural animals. Grazing could potentially alter heron foraging success if changes in vegetative cover made it more difficult to catch prey, but no data are available that address this question.

Food supply problems can also threaten Great Blue Heron populations. Pratt (1972) and Blus and Henney (1981) reported significant overwinter mortality of herons on the Pacific coast of the United States due to starvation. In addition, Butler (1995) found that starvation due to a lack of foraging skill was the most important factor affecting juvenile survival during the first winter after fledging. Food supply problems can also affect heron breeding productivity if adult herons cannot obtain enough food to adequately feed their young (Gebauer and Moul 2001). However, food limitations are currently viewed as a less important threat than disturbance from predators and humans (Butler 1997; Vennesland 2000).

Contamination from human industrial activities likely caused the abandonment of one colony near Vancouver Island in the late 1980s (Elliott et al. 1989), but this threat is declining in British Columbia and is currently not seen as a widespread problem (Elliott et al. 2003).

Adverse weather can also impact heron populations. Forbes et al. (1985b) suggested that low rainfall and/or extensive sunshine could increase breeding productivity, implying that high rainfall and limited sunshine might reduce productivity. This effect could be due to hypothermia in nestlings, or reduced prey delivery from attending adults (Gebauer and Moul 2001). Tree or nest blowdown has also been implicated in the death of nestlings (Burkholder and Smith 1991).

Habitat threats

Threats to Great Blue Heron habitat in British Columbia include the loss of breeding and foraging areas to urban development, forestry, hydroelectric power development, and natural processes. Urban development and forestry are the main causes of habitat loss. Heron populations in British Columbia are concentrated around the Georgia Depression ecoprovince and in valley bottoms of the Interior, and these two habitats are also the primary centres of human activity in the province (Moore 1990; Butler 1997; Campbell et al. 2001). Forestry can impact heron habitat through the removal of active or potential nest trees (Bjorkland 1975; Werschkul et al. 1976; Gebauer and Moul 2001). Habitat is also threatened by weather-related problems such as tree or nest blowdown (see previous section). Forest fragmentation may increase access to, or visibility of, breeding colonies for predators, such as Bald Eagles, thereby reducing the amount of suitable breeding habitat available to herons (Vennesland 2000).

Legal Protection and Habitat Conservation

The Great Blue Heron, its nests and eggs are protected year-round from direct persecution by the provincial *Wildlife Act,* as well as the *Migratory Birds Convention Act*. Scare/kill permits were provided up to 1998 to control herons feeding on fish stocks, but these have since been revoked (Butler and Baudin 2000).

Many sites are currently protected within regional or municipal parks, wildlife management areas, or have other protected status directly related to the occupancy of breeding herons (Gebauer and Moul 2001). This includes colonies at Vaseux Lake and Wilmer Wildlife Area in the Kootenay region, as well as the four largest colonies in the lower Fraser Valley (67% of all active nests in the area, $n = 1070$) and two colonies on Vancouver Island and the Gulf Islands (39% of all active nests in the area, $n = 459$) (Gebauer and Moul 2001). In total, 59% of all active nests in the Georgia Depression are currently protected ($n = 1529$ active nests). The continuing efforts of the Wild Bird Trust are now directed at mid-sized colonies to secure covenants on private and commercial lands (Butler and Baudin 2000; Gebauer and Moul 2001). The Delta Farmland Trust has recently established grassland set-asides to protect heron foraging habitat, and several projects have been undertaken to restore original habitat in areas that have been altered by causeways and dikes (Gebauer and Moul 2001).

Under the results based code, some critical foraging and nesting habitats could be addressed through establishment of old growth management areas, riparian management areas and wildlife tree retention areas. In addition, the "wildlife habitat feature" designation may also protect known nest sites. Although buffers are not currently enabled under this designation, licensees should voluntarily maintain a buffer to minimize disturbance and maintain the integrity of nesting habitat. However, many breeding colonies are located on private land, and the protection of heron nesting locations on Crown land should be considered a priority because most herons nest on private land where less regulatory control is available.

For colonies on private land, best management practices guidelines have been created by the British Columbia Ministry of Water, Land and Air Protection, Region 1 (Vancouver Island). These voluntary guidelines outline how developers can help to protect breeding herons in existing developed areas (K. Morrison, pers. comm.). In addition, herons on private land can be protected through zoning at the municipal level (M. Henigman, pers. comm.).

Identified Wildlife Provisions

Wildlife habitat area

Goals

Protect heron nesting sites and adjacent foraging areas from human disturbance and habitat loss or alteration.

Feature

Establish WHAs at nesting areas and nesting colonies. Important foraging sites (i.e., concentrations of herons feeding on a regular basis) may be recommended for WHA establishment by the Canada/U.S. Heron Working Group.

Size

Typically 80 ha but will ultimately depend on site-specific factors. Size should depend on the number of individuals using locations for breeding and/or foraging (Butler 1997; Gebauer and Moul 2001) and density of use. Other important factors to be considered include location, topography, proximity of foraging sites (for colonies), relative isolation, and degree of habituation to disturbance.

Design

The design of the WHA should consider the colony size, location, proximity of foraging sites, relative isolation, and degree of habituation to disturbance. The core area should be approximately 12 ha and include known nest sites, potential nesting areas and, where appropriate, foraging areas and flight paths. Ideally, the boundary of the core area should be approximately 200 m radius from the edge of the colony or important habitat feature(s). A 300 m management zone should also be included to minimize disturbance to all components of the WHA (nest site, foraging sites).

In areas where human disturbance is a concern, incorporate boundaries that may act as barriers to humans wherever possible. Carlson and McLean (1996) showed that barriers that completely excluded humans were more effective than management zones that allowed some intrusion, and breeding productivity was higher at sites with stronger barriers (e.g., ditches and fences).

For existing developed sites in areas of high human use, a minimum naturally vegetated strip around all breeding colonies of at least 50 m is recommended by the best management practices guidelines produced by the Ministry of Water, Land and Air Protection in Region 1 (K. Morrison, pers. comm.).

General wildlife measures

Goals

1. Minimize disturbance during the breeding season (15 February to 31 August) and between 1 November and 31 March for colonies that occupy areas year round.
2. Maintain important structural elements for nesting and foraging (i.e., suitable nest trees, non-fragmented forest around nest trees, wetland characteristics for foraging if applicable, roost trees, and ground barriers to exclude mammalian predators).

Measures

Access

- Do not develop roads or trails within the core area. Road and trail construction or blasting in the management zone should not occur between 15 February and 31 August.
- Limit access on existing roads and trails between 15 February and 31 August. Types and levels of use must not exceed levels that customarily occur during the breeding period.

Harvesting and silviculture

- Do not harvest within the core area.
- Do not harvest within the management zone between 15 February and 31 August.
- No silvicultural activities, except restoration or enhancement activities, should occur within the core area. In the management zone, no mechanized activities that exceed noise or disturbance levels (including distance from colony) previously experienced during this period should occur between 15 February and 31 August.
- Within a management zone that has few trees other than the nest trees, restocking and/or silvicultural techniques can be applied to enhance rapid development and protection of the stand.

Pesticides

- Do not use pesticides.

Range

- Maintain WHA in a properly functioning condition.
- Control level of livestock use and plan grazing to ensure that the structural integrity of stands of emergent vegetation are maintained. Fencing could be required by the statutory decision maker to meet goals described above.

Recreation

- Do not develop recreation trails, structures, or facilities.

Additional Management Considerations

Avoid disturbance within 500 m of colonies and adjacent foraging habitats between 15 February and 31 August and between 1 November and 31 March for year-round colonies. Some colonies may have become habituated to some levels of disturbance, in which case it may not be necessary to refrain from activities. In general, motorized, loud, or continuous activities are more disturbing than non-motorized activities. When incorporating barriers to minimize access or disturbance, it is better to use barriers that completely exclude humans than those that allow some intrusion (Carlson and McLean 1996).

Where permanent activities or habitat modifications are planned, vegetative screening should be planted or maintained between the activity and the colony as close to the activity area as possible. Where possible, the trees/shrubs planted should be a mixture of deciduous and coniferous, and half should be of the same species currently used for nesting.

Consider constructing a fence or other barrier between the activity and vegetative screening.

Protect heron foraging resources, especially those within 4 km of colonies and in key wintering areas, from development, degradation, and pollution, particularly aquaculture operations and discharge of toxic effluents. Coastal heron concentrations occur on estuaries and other low gradient intertidal habitats and on adjacent farmlands during the winter. Interior birds feed in marshes and along shallow shorelines of lakes and rivers; during winter they need areas of open (unfrozen) water.

Maintain perch trees adjacent to major summer and winter foraging areas.

Prevent further loss of important coastal and interior riparian mature/old-growth forest nesting habitat to urban/suburban and forest development.

Information Needs

1. Monitoring of key breeding locations is ongoing on the coast and should be continued at the existing, or a more intensive level.
2. Heron surveys on foraging grounds.
3. Current and future impact of Bald Eagle disturbance at coastal and interior heron colonies. Eagle populations are increasing, but it is not known how long they will continue to do so, whether human activities are enhancing their populations, or how this activity may change the location or distribution of breeding herons.

Cross References

Marbled Murrelet, "Queen Charlotte" Goshawk, Spotted Owl, "Vancouver Island" Northern Pygmy-Owl

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Long-billed Curlew

Numenius americanus

Original[1] prepared by I.A. (Penny) Ohanjanian

Species Information

Taxonomy

The Long-billed Curlew (*Numenius americanus*) is the largest member of the sandpiper family, Scolopacidae, to breed in British Columbia. Two subspecies are recognized by some researchers, the lesser Long-billed Curlew (*N. americanus parvus*) which nests in Canada and the northern United States, and the greater Long-billed Curlew (*N. americanus americanus*) which occurs farther south (Allen 1980; Cannings 1998). Genetic work has not yet been carried out to determine if this distinction is valid.

Description

The Long-billed Curlew is a large, long-legged shorebird found primarily in grassland habitats during the breeding season. It has mottled, light brown plumage, a buff-coloured breast, and cinnamon underwing linings. The bill is long and curves downwards, reaching a length of up to 195 mm in females and 140 mm in males (Jenni et al. 1982).

Distribution

Global

In the United States, Long-billed Curlews breed west of the Mississippi River in Washington, Oregon, northeastern California, Idaho, Nevada, central Utah, northern New Mexico, northern Texas, northwestern Oklahoma, Wyoming, Montana, Colorado, North Dakota, South Dakota, Nebraska, and western Kansas (Sauer et al. 2000). Since the early 1900s they have been extirpated from much of their historic range (Allen 1980; De Smet 1992). The major wintering areas for Long-billed Curlews are the coastal lowlands of California, the inland grasslands of the Central Valley, west Texas, eastern New Mexico, and along the Gulf coast in Texas and Louisiana (Sauer et al. 2000). De Smet (1992) has also reported this species wintering in the coastal lagoons of southern Mexico and south to Venezuela.

During the last century in Canada, curlew numbers have declined and the breeding range has shrunk. Formerly a breeder in southern Manitoba, the species is now listed as extirpated (De Smet 1992; Sauer et al. 2000). Long-billed Curlews remain in Saskatchewan (Smith 1996, cited by Hill 1998) but no longer occupy some of their historic range in the southeastern portions of the province (De Smet 1992). In Alberta, Long-billed Curlews breed in the southern half of the province, with the highest densities in the grasslands south of Red Deer (Hill 1998).

British Columbia

Non-breeding birds are widely distributed through the south-central Interior, north to the Nechako Lowland. This shorebird appears sporadically on the south coast during spring and autumn migration, where it is restricted to estuaries, mudflats, airports, or other open grassy areas.

The Long-billed Curlew breeds in the southern Interior. Breeding areas are fairly disjunct and include areas from (1) Lillooet north to Quesnel (Chubb Lake), (2) the Chilcotin west to Alexis Creek, (3) the south Okanagan and lower Similkameen valleys, (4) the North Okanagan, (5) the Thompson-Nicola, and (6) the East Kootenay Trench (Cannings 1999). Small populations breed in agricultural cropland near McBride and in the Creston Valley (Van Damme 1996, cited by Cannings 1999). Records outside the periphery of its breeding range suggest that it may breed over a slightly larger range than currently documented. Breeding does not occur on the coast.

1 Volume 1 account prepared by M. Sarell.

Long-billed Curlew
(Numenius americanus)

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Forest region and districts

Coast:[2] Campbell River, Chilliwack

Northern Interior: Fort St. James (possible), Prince George, Vanderhoof

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin, Headwaters, Kamloops, Kootenay Lake, Okanagan Shuswap, Quesnel, Rocky Mountain

Ecoprovinces and ecosections

CEI: CAB, CHP, FRB, QUL

COM: WIM

GED:[2] FRL, NAL

SBI: NEL

SIM: EKT, ELV, SCM, UCV, UFT

SOI: GUU, NIB, NOB, NOH, NTU, OKR, PAR, SHB, SOB, SOH, STU, THB

Biogeoclimatic units

BG: xh1, xh2, xh3, xw, xw1, xw2

CDF: mm

CWH: dm, vh1, vh2, vm1, xm1

ICH: xw

IDF: dk1, dk2, dk3, dk4, dm2, mw1, mw2, mw2a, xh1, xh1a, xh2, xh2a, xm, xw

PP: dh1, dh2, xh1, xh2, xh2a

SBS: dh, dw3, mk1

Broad ecosystem units

AB, BS, CF (in FRL only), DF, ES, ME, SS

Elevation

280–1220 m (Campbell et al. 1990; Fraser et al. 1999)

Life History

Diet and foraging behaviour

On the breeding grounds, adult Long-billed Curlews have been observed eating ground beetles (Allen 1980), and grasshoppers (Redmond and Jenni 1985) as well as earthworms in nearby irrigated hayfields (Ohanjanian 1985). Grasshoppers and beetles are the predominant prey of chicks, and caterpillars and spiders are also eaten (Redmond and Jenni 1985). In wintering habitats, the Long-billed Curlew feeds on mud crabs, fiddler crabs, ghost shrimps, and occasionally small fishes (De Graaf et al. 1991).

Reproduction

Long-billed Curlews first breed at 2–3 years (females) and 3–4 years (males) (Redmond and Jenni 1986). They nest in dry, open grasslands with low profile vegetation. Nests are shallow scrapes on the ground, from 130 to 275 mm in diameter and approximately 20 to 65 mm deep (Allen 1980). Nest cups may be lined with leaves, twigs, sheep or rabbit pellets, small stones, and grass (Allen 1980; Jenni et al. 1982). Four eggs are usually laid over 1 week (Jenni et al. 1982; Redmond 1984; Campbell et al. 1990). Clutches are initiated from mid-April until the first half of May, with most occurring in the third week of April (Redmond 1984; Cannings et al. 1987). More northerly birds may initiate clutches slightly later than those in the south, but it is unlikely that eggs are laid in any location after mid-May. Both adults share incubation (which takes about 28 days) (Allen 1980) and depend on their cryptic plumage to camouflage their presence. When incubating birds are flushed, they may take up to 1 hour to return to the nest (Allen 1980).

Chicks hatch synchronously, and adults and broods remain within 100–300 m of the nest site for the first few days (Jenni et al. 1982), after which time they become highly mobile. Some chicks become capable of flight at 35–40 days (Jenni et al. 1982), although Fitzner (1978) reports 40–45 days to fledging. Females usually depart from the breeding grounds prior to their chicks being fledged, leaving males to tend broods after the first few weeks (Redmond 1984; De Smet 1992). The young of birds that initiate clutches in the third week of April are generally fledged by the end of June. This date may extend into mid-July for later breeders.

Site fidelity

Both male and female Long-billed Curlews show strong site fidelity, returning each year to previous nesting territories (Redmond 1984). There is evidence that male curlews tend to return to their place of birth to set up a territory and attract a mate when they reach sexual maturity. Long-billed

2 Non-breeding.

Curlews are monogamous and have long-term pair-bonds (Redmond 1984).

Home range

Nesting territory is highly variable in size. In the Chilcotin, nesting curlew densities ranged from a low of 0.73 pairs/100 ha of suitable habitat to 3.4 pairs/100 ha (Ohanjanian 1987). Hooper and Pitt (1996) found breeding densities ranged from 0.7 pair/100 ha to 2.1 pair/100 ha between 1987 and 1992. In the East Kootenay, densities at Skookumchuck ranged from 1 pair/20 ha (1985) to 1 pair/30 ha (Ohanjanian 1992). In southwestern Idaho estimates ranged from 1.74 males/100 ha suitable habitat to a maximum of 8.4 males/100 ha (Jenni et al. 1982). In southeastern Washington, breeding densities ranged from 1 pair/172.6 ha to 1 pair/66 ha in the densest area (Allen 1980). Broods require more space than nesting adults, and home ranges of up to 1000 ha are recorded in the literature (Jenni et al. 1982). Jenni et al. (1982) suggest that a curlew brood requires a minimum of 250 ha.

Movements and dispersal

Migrants appear from late March through early April during most years. Females may depart from the nesting areas as early as the latter half of June (Redmond 1984) with some males following soon after. Juveniles of the year remain the longest on the breeding grounds, forming feeding flocks and then departing at the end of July (Allen 1980; Redmond 1984).

Habitat

Structural stage

2: herb

Important habitats and habitat features

Nesting and brood rearing

Long-billed Curlews breed in areas with maximum visibility, largely because of co-operative anti-predator mobbing behaviours. They therefore need large contiguous openings of grassland and prefer areas that are gently sloping (Hooper and Pitt 1996). During pre-laying and incubation, areas with low vegetation (<10 cm tall preferred) and a maximum vertical coverage value of 40% at the height of a curlew's eyes (30 cm) are used preferentially (Allen 1980; Jenni et al. 1982; Ohanjanian 1992). During brood-rearing, higher vegetation (up to 30 cm) may be used, and irregular spacing of taller grass clumps complement chicks' cryptic colouration and provide hiding and shading opportunities for them (Allen 1980; Jenni et al. 1982). Mean width of openings used for nesting at Skookumchuck was 547 m (range 250–900) at the narrowest point (Ohanjanian 1992). A buffer of 300–500 m between nesting territories and non-suitable habitat or human activities has been observed by Bicak et al. (1982) and Jenni et al. (1982).

Use of new crested wheatgrass seedings has been documented in British Columbia, where a high proportion of native plant species were still present and the vegetative profile was low (Ohanjanian 1985). Such seedings will not continue to support the species if left ungrazed; in Idaho, they were avoided because their vertical coverage values were too high (Jenni et al. 1982).

Migration

This shorebird appears sporadically on the south coast during spring and autumn migration, where it is restricted to estuaries, mudflats, airports, or other open grassy areas (Campbell et al. 1990).

Foraging

Insects are obtained primarily on the grasslands. Curlews may be seen soon after their arrival in spring, however, earthworms provide immediate, high quality protein in irrigated hayfields (Ohanjanian 1985).

Conservation and Management

Status

The Long-billed Curlew is on the provincial *Blue List* in British Columbia. It is designated as a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	ID	MT	OR	WA	Canada	Global
S3B, SZN	S3B	S3B, SZN	S4B, SZN	S3S4	S2B, S2N	N4B	G5

Trends

Population trends

The population of Long-billed Curlews in the North Okanagan Valley declined considerably between 1982 and 1995 (Cannings et al. 1987; Cannings 1999). The south Okanagan birds appear to fluctuate, and may have done so historically as well (Cannings 1999). The East Kootenay population has increased since the 1970s (Ohanjanian 1992), and new reports of birds at Creston (Van Damme 1996, cited by Cannings1999) suggest that they may be expanding their range in this region. There is no hard data on current population trends elsewhere in British Columbia. The overall population appears to be stable, with some areas increasing and other decreasing (Cannings 1999).

Habitat trends

Habitat continues to be lost due to forest encroachment, subdivisions, and conversion of rangelands to agricultural use.

Threats

Population threats

In British Columbia, the Long-billed Curlew has a restricted breeding distribution and small population size. Cannings (1999) estimated a minimum population of about 250 breeding pairs. The Long-billed Curlew is a ground-nesting species and therefore experiences high rates of predation on eggs and young. Predators of nests or chicks include coyotes, weasels, badgers, magpies, ravens, dogs, and snakes (Allen 1980; Redmond 1984). If nests are predated, adults do not usually re-nest (Cannings 1999).

Habitat threats

Major threats to Long-billed Curlew habitat are urbanization, forest encroachment due to fire suppression, noxious weeds, and conversion of native rangelands to agricultural crops such as ginseng and hay (Ohanjanian 1992; Cannings 1999). Hay fields are generally too dense for small chicks to move about in. There are reports of Long-billed Curlews nesting in grain fields (Cannings 1999); their productivity in these habitats, however, has not been ascertained. Cheatgrass (*Bromus tectorum*), an introduced invasive grass, is tolerated and may even be preferred by Long-billed Curlews but other invasive species, particularly knapweed, are thought to be avoided by curlews.

All-terrain vehicles (ATVs) may pose a serious threat in localized areas. Range quality may become degraded as ATV tracks destroy vegetation and facilitate topsoil erosion. ATVs may also cause direct mortality to Long-billed Curlews in several ways: eggs may become overheated leading to heat stress and embryo death while adults are flushed off nests, predators such as ravens may be attracted to chicks by adult alarm calls while they mob human intruders, and nests or chicks may be run over.

Although Long-billed Curlews tolerate and may even benefit from livestock grazing, they may be impacted (e.g., trampling) or disturbed by heavy livestock during critical times during the breeding season.

Pesticides, particularly organochlorines, may also impact curlew breeding success.

Legal Protection and Habitat Conservation

The Long-billed Curlew, its nests, and its eggs are protected under the federal *Migratory Birds Convention Act* and the provincial *Wildlife Act*.

For the most part, very little of known curlew nesting habitat is protected. Cannings (1999) estimates that <10% of curlews nest within lands protected for conservation. In the south Okanagan and Similkameen, only 6% of curlew habitat is considered to be within lands designated for conservation purposes and 47% is within private land (MELP 1998). In the Cariboo/Chilcotin, some protection is available for a few pairs of Long-billed Curlews at the Junction Provincial Park (410 ha) (Ohanjanian 1987; T. Hooper, pers. comm.). There are also a few pairs in the south Okanagan Wildlife Management Area and at White Lake, which is under long-term lease to Nature Trust (Cannings 1999). In the East Kootenay, one or two pairs nest on properties owned by the province at Bummer's Flats and on Wolf Creek Road. Churn Creek and Lac du Bois may also contain nesting curlews.

Under the results based code, range use plans that consider the requirements of this species may be sufficient to meet the needs of the species. However for a species to be specifically addressed within these plans they must be designated as Identified Wildlife. In some cases, current grazing practices may be adequate to maintain habitats for this species and therefore it may not be necessary to establish a WHA. This assessment must be made case by case.

Identified Wildlife Provisions

Wildlife habitat area

Goals

Maintain suitable nesting and brood rearing habitat for multiple pairs.

Feature

Establish WHAs over breeding areas occupied by multiple pairs. Breeding areas include nesting, incubation, and brood rearing habitats.

Size

Typically between 250 and 500 ha but will ultimately depend on the number of pairs and area of suitable habitat. Larger contiguous openings will support more curlews (denser numbers) than smaller areas (Bicak et al. 1982).

Design

The WHA should include flat to moderately rolling terrain and short grass cover (ideally ≤10 cm tall during the pre-laying period and up to 25 cm during brood-rearing) (Jenni et al. 1982). Ideally the WHA should include as large an area of grassland as possible but should include ~250 ha of brood rearing habitat with scattered clumps of grasses 20–30 cm in height (this may include the nesting territory). The WHA should be at least 250 m wide at its narrowest point but should include a 500 m buffer of similar open habitat (Jenni et al. 1982) to protect against disturbance. The buffer should be managed similar to the core so does not need to be distinguished but should be considered when designing WHA boundaries.

General wildlife measures

Goals

1. Provide low profile vegetation (<10 cm) for nesting in April.
2. Provide vegetation that is approximately 25 cm in height for brood rearing in May.
3. Minimize disturbance from humans or livestock during critical times throughout the breeding season (1 April to 15 July).
4. Maintain native bunchgrass in brood-rearing areas.
5. Minimize forest encroachment.

Measures

Access

- Do not construct roads unless there is no other practicable option.
- Limit road use during critical times during the breeding season (1 April to 15 July) when considered necessary by statutory decision maker. Contact MWLAP staff for site-specific times.

Pesticides

- Do not use pesticides.

Range

- Control timing and distribution of livestock grazing to avoid disturbances during the breeding season. Consult MWLAP for site-specific times.
- Plan livestock grazing to maintain grass cover in nesting areas that is on average <10 cm in height when curlews return in spring.
- Avoid concentrating livestock during the breeding season (1 April to 15 July) particularly during the incubation period. Place salt and water troughs in treed areas wherever possible to prevent livestock concentrations in the open where nests may occur. When it is necessary to move livestock through a WHA during the incubation period (generally 15 April to 31 May) and there is no other practicable option, use forest or shrub areas or areas immediately adjacent to trees (<20 m) rather than in the middle of openings. Consult MWLAP for specific times.
- Do not use fire in nesting areas during egg-laying or brood-rearing times.

Recreation

- Do not establish recreational trails.

Additional Management Considerations

Prevent or restrict motorized recreation vehicles such as ATVs and dirt bikes within WHA particularly between 15 March to 15 July.

Where appropriate, and the habitat capability is high, revegetate crested wheatgrass seedings to native grass species.

Control forest encroachment using logging in combination with burning or other suitable methods.

Information Needs

1. Population size and trend.
2. Determine if Long-billed Curlews breed in Churn Creek Protected Area.
3. Research on brood rearing and rearing habitat requirements is needed.

Cross References

Grasshopper Sparrow, Sage Thrasher

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Sandhill Crane

Grus canadensis

Original[1] prepared by Martin Gebauer

Species Information

Taxonomy

Of the 15 crane species in the world (Sibley 1996), two breed within North America: Sandhill Crane (*Grus canadensis*) and Whooping Crane (*Grus americana*) (NGS 1999). Early literature recognized three subspecies of Sandhill Crane (AOU 1957), however, more recent literature recognizes six subspecies: Lesser (*G. canadensis canadensis*), Canadian (*G. canadensis rowani*), Greater (*G. canadensis tabida*), Florida (*G. canadensis pratensis*), Cuban (*G. canadensis nesiotes*), and Mississippi (*G. canadensis pulla*) (Walkinshaw 1973, Tacha et al. 1992) of which the first three subspecies occur in British Columbia (Cannings 1998).

The Lesser Sandhill Crane is a common migrant through British Columbia, as is the Greater Sandhill Crane and possibly the Canadian Sandhill Crane breed. The Greater Sandhill Crane is thought to be the subspecies breeding in the Lower Mainland, the Queen Charlotte Islands, Vancouver Island, the Hecate Lowlands, and interior areas of the province (Campbell et al. 1990). Some authors have questioned the splitting of Greater and Canadian Sandhill Cranes into separate subspecies since a continuum in morphology and random pairing among the supposed subspecies has been demonstrated (Tacha et al. 1992).

Description

These large grey birds are perhaps most often confused with the morphologically similar, but taxonomically different, Great Blue Heron (*Ardea herodias*). Sandhill Cranes can be distinguished by their large size, overall grey colouration (often stained with rusty colouration), with dull red skin on the crown and lores, whitish chin, cheek and upper throat, and black primaries. Young are more brownish and without a bare forehead patch (Godfrey 1986; NGS 1999).

Distribution

Global

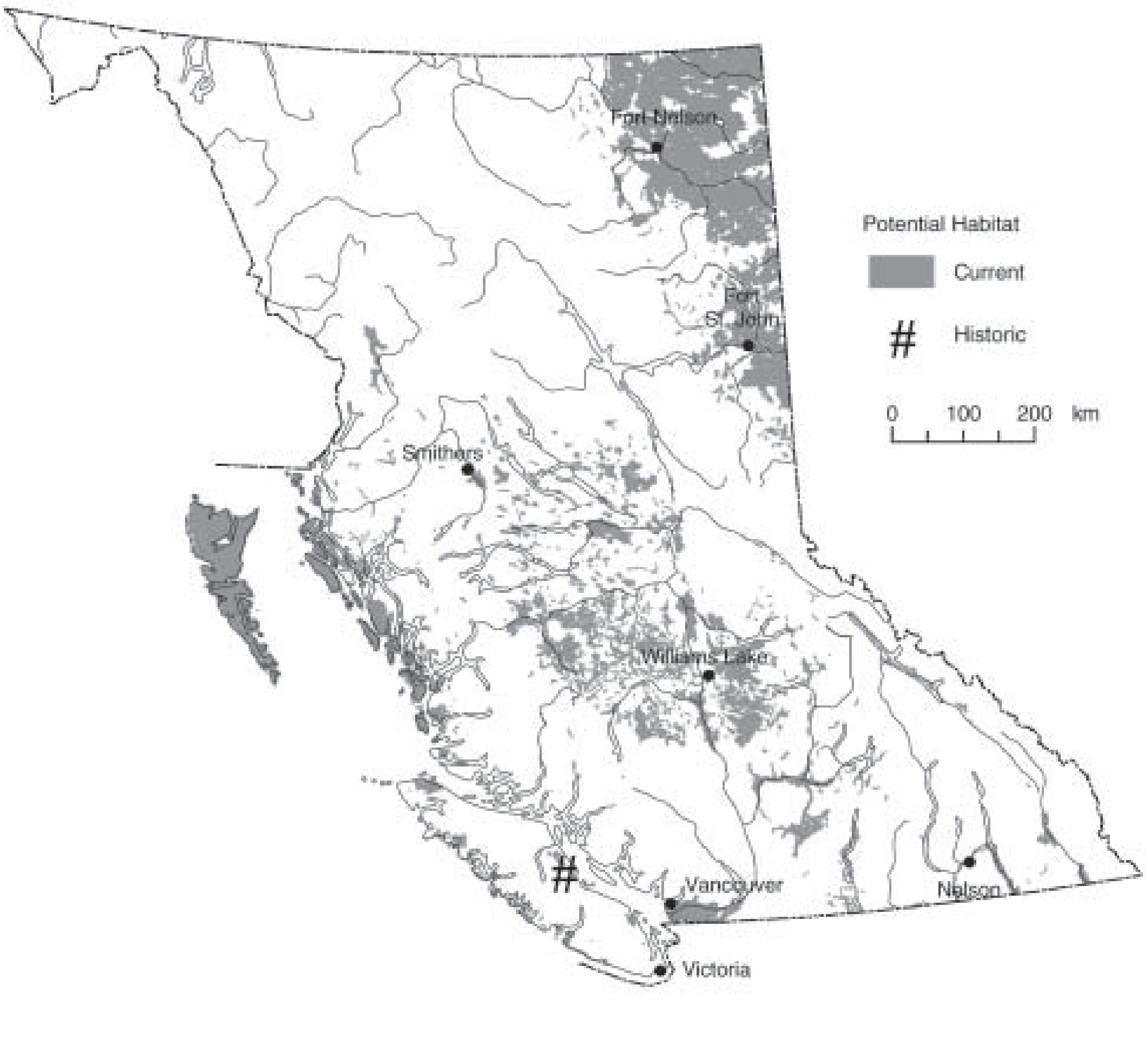
The Sandhill Crane is restricted to North America breeding primarily from the northwestern United States (e.g., northwestern California, Nevada, and Oregon) and the Great Lakes area north to Alaska, and the Northwest Territories including Baffin and Victoria Islands. Resident populations breed in the Mississippi River delta, Florida and southern Georgia, and Cuba (Tacha et al. 1992). Sandhill Cranes winter from central California, southeastern Arizona east to central Texas, in scattered areas of the Gulf Coast and southern Florida, and south to the states of Sinaloa, Jalisco, Chihuahua, Durango, and Veracruz in Mexico (Tacha et al. 1992; Howell and Webb 1995; Drewien et al. 1996).

British Columbia

The Sandhill Crane has a widespread breeding distribution in British Columbia, although the breeding distributions of the three separate subspecies is not well understood. Known breeding areas include much of the central Interior, the Queen Charlotte Islands, the central mainland coast, Mara Meadows near Enderby, East Kootenay, northeastern British Columbia near Fort Nelson, and at Pitt Meadows and Burns Bog in the Lower Mainland (Gebauer 1995; Cooper 1996). The Greater Sandhill Crane is thought to breed throughout most of the Interior, whereas the Canadian Sandhill Crane is thought to breed on the coast (Cooper 1996) but may also breed in the central Interior and northeast (Littlefield and Thompson 1979). Lesser Sandhill

1 Volume 1 account prepared by J. Cooper.

Sandhill Crane
(Grus canadensis)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Cranes occur in the province in large numbers primarily during migration, but may also breed in the northeast (Cooper 1996). Stopover points for migrating Sandhill Cranes include White Lake in the south Okanagan, Lac Le Jeune in the Kamloops area, Becher's Prairie near Williams Lake, the Kispiox Valley north of Smithers, Nig Creek northwest of Fort St. John and Liard Hot Springs in north-central British Columbia (Campbell et al. 1990).

Forest region and districts

Coast: Campbell River, Chilliwack, North Coast, North Island, Queen Charlotte Islands, South Island, Squamish

Northern Interior: Fort Nelson, Kalum, Mackenzie, Nadina, Peace, Prince George, Skeena Stikine, Vanderhoof

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin, Headwaters, Kootenay Lake, Okanagan Shuswap, Quesnel, Rocky Mountain

Ecoprovinces and ecosections

BOP: CLH, HAP, KIP, PEL

CEI: BUB, CAB, CAP, CHP, FRB, NAU, NEU, QUL, WCR, WCU

COM: CPR, CRU, FRL, HEL, KIM, KIR, NAB, NAM, NIM, NPR, NWL, OUF, QCL, SKP, WIM, WQC

GED: FRL, LIM, NAL

NBM: LIP, TEB, TEP

SBI: BAU, ESM, MAP, MCP, NEL, NHR, PAT, SHR

SIM: BBT, CAM, EKT, QUH, SCM, SFH, SHH, SPM, UCV, UFT

SOI: GUU, NIB, NOB, NTU, OKR, SHB, SOB, STU, TRU, (THB – eastern end only)

TAP: ETP, FNL, MAU, MUP, PEP, TLP

Biogeoclimatic units

BG: all

BWBS: dk1, dk2, mw1, mw2

CDF: mm

CWH: all

ICH: all

IDF: dk1, dk1a, dk1b, dk2, dk3, dk4, mw1, mw2, mw2a

MS: all

PP: all

SBPS: dc, mc, mk, xc

SBS: dk, dw1, dw2, dw3, mc, mc1, mc2, mc3, mh, mk1, mk2, mw

Broad ecosystem units

BB, BG, BS, CB, CF, ES, ME, OW, RE, SS, TF, WL

Elevation

Breeding: sea level to 1220 m

Non-breeding: sea level to 1510 m (Campbell et al. 1990)

Life History

Diet and foraging behaviour

Sandhill Cranes are opportunistic foragers, feeding on both animal (primarily invertebrates) and plant foods (Walkinshaw 1973; Mullins and Bizeau 1978; Ballard and Thompson 2000). In Nebraska, cranes feeding in cornfields ate >99% corn whereas those feeding in native grasslands and alfalfa fields consumed 79–99% invertebrates (Reinecke and Krapu 1986). Invertebrates consumed by cranes in Nebraska included earthworms, beetles, crickets, grasshoppers, cutworms, and snails. In Idaho, plants made up 73% of the total food consumption of summering cranes, and insects and earthworms made up the remaining 27% (Mullins and Bizeau 1978). Large flocks of staging cranes feeding on agricultural grain crops has lead to crop depredation in some areas (Tacha et al. 1985; McIvor and Conover 1994a, 1994b). Other foods taken by Sandhill Cranes include crayfish, voles, mice, frogs, toads, snakes, nestling birds, bird eggs, berries, and carrion (Cooper 1996).

Reproduction

Dates for 20 clutches in British Columbia ranged from 2 May to 25 June with 50% recorded between 9 and 24 May. Clutch size ranged from one to three eggs with 84% having two eggs (Campbell et al. 1990). Dates from two nests in British Columbia suggest an incubation period of 33–34 days (Campbell et al. 1990), more than the 28–32 days reported by Ehrlich et al. (1988). Dates for 47 broods in British Columbia ranged from 15 May to 1 September with 57% recorded between 15 June and 15 July. Sizes of 46 broods ranged from one to two young with 72% of the broods having one young (Campbell et al. 1990). Fledgling period ranges from 65 to 70 days (Ehrlich et al. 1988; Campbell et al. 1990). Replacement clutches may be laid if the first clutch is lost within an interval of about 20 days (Nesbitt 1988).

Site fidelity

Drewien et al. (1999) found that radiomarked Sandhill Cranes of the Rocky Mountain population exhibited strong site fidelity to summer and winter grounds during successive years, and that juveniles apparently learned traditional use patterns from parents. Tacha et al. (1984) found that individuals (particularly established pairs) consistently returned to the same wintering grounds. However, preliminary data in central British Columbia suggest that site fidelity of breeding pairs between years is not strong (Cooper 1996).

Home range

Sandhill Crane territories at Grays Lake, Idaho, with the densest known nesting concentrations, averaged 17 ha (Drewien 1973). At Malheur National Wildlife Reserve (NWR), territories averaged approximately 25 ha (Littlefield and Ryder 1968). Walkinshaw (1973) found average territory sizes ranging from 53 to 85 ha in Michigan. Territory sizes of cranes nesting in British Columbia have not been determined.

Movements and dispersal

Three migration routes are known in British Columbia, each of which is used in spring and autumn: coastal, central Interior, and northeastern Interior. Cranes migrating along the coastal route enter British Columbia over Juan de Fuca Strait and are occasionally seen in the Barkley Sound and Johnstone Strait regions. The main passage of migrants occurs in early April, whereas the autumn movement peaks in October (Campbell et al. 1990). Birds using the coastal route (~3500) are suspected of nesting in the coastal islands of British Columbia and southeast Alaska (Campbell et al. 1990). In the central Interior, the migration route follows the Okanagan Valley to Peachland, then over Chapperon Lake and the Kamloops area, through the central Chilcotin-Cariboo, over the Fraser Plateau following the Bulkley and Kispiox valleys, past Meziadin Lake and into southeastern Alaska. Between 22 000 and 25 000 birds are thought to use this route (Campbell et al. 1990). The main spring movement is at the end of April, with the main passage in the fall from late September to early October. Known stopover points include White Lake in the south Okanagan, Lac Le Jeune, Becher's Prairie west of Williams Lake, and the Kispiox Valley north of Hazelton (Campbell et al. 1990). In northeastern British Columbia, between 150 000 and 200 000 birds move through the Peace River area on their way to Alaskan and Siberian breeding grounds (Kessel 1984; Tacha et al. 1984), generally passing over Nig Creek and Cecil Lake (Campbell et al. 1990). Spring migration occurs from late April to early May, whereas fall migration is generally during the second and third weeks of September (Campbell et al. 1990).

After hatching, young leave the nest and forage with their parents around the perimeter of the natal wetland, primarily in sedge meadows. Once young have fledged, localized congregations occur in pre-migration staging areas (Gebauer 1995). In the fall at Burns Bog, cranes moved from roosting areas within the Bog to agricultural fields for foraging each day, moving distances of 2–4 km (Gebauer 1995). Lewis (1975) found the average distance of flight movements between feeding and roosting areas to range from 2 to 16 km.

Habitat

Structural stage	Roosting	Nesting	Escape	Screen
1: non-vegetated or sparsely vegetated	x	x		
2: herb	x	x		
3a: low shrub	x	x		
3b: tall shrub	x	x	x	x
4: pole/sapling			x	x
5: young forest			x	x
6: mature forest			x	x
7: old forest			x	x

Important habitats and habitat features

Nesting

Typical breeding habitats include isolated bogs, marshes, swamps and meadows, and other secluded shallow freshwater wetlands generally >1 ha in size surrounded by forest cover. Emergent vegetation such as sedges (*Carex* spp.), Cattail (*Typha latifolia*), bulrush (*Scirpus* spp.), Hardhack (*Spiraea douglasii*), willows (*Salix* spp.), and Labrador Tea (*Ledum groenlandicum*) are important for nesting and brood rearing (Robinson and Robinson 1976, Runyan 1978, Littlefield 1995a). Nesting wetlands are usually secluded, free from disturbance, and surrounded by forest. In coastal areas, brackish estuaries are used for rearing broods. Johnsgard (1983) and Walkinshaw (1949) identified sphagnum bogs as important nesting habitats for Greater Sandhill Cranes. Most sightings of cranes in Burns Bog were from wet and dry heathland (i.e., sphagnum) vegetation communities (Gebauer 1995).

Forested buffers around nesting marshes are likely critical for relatively small (1–10 ha) wetlands. Forests are used for escape cover by young and provide a buffer against disturbance. Although the Sandhill Crane has occasionally been reported as nesting in revegetating clearcuts (Campbell et al. 1990), clearcuts are generally not suitable habitat alternatives to wetlands.

Nests consist of large heaps of surrounding dominant vegetation, usually built in emergent vegetation or on raised hummocks over water (Melvin et al. 1990; Campbell et al. 1990). Robinson and Robinson (1976) found the average depth of water at five nests in the Pitt River Valley to be 4.3 cm in May and 13 cm in June. In Michigan, cranes selected nest sites in or near seasonally flooded emergent wetlands and avoided forested uplands (Baker et al. 1995). Nests may adjust (i.e., float) to slight increases in water level (Tacha et al. 1992).

Foraging

One of the most important habitat characteristics for Sandhill Cranes is an unobstructed view of surrounding areas and isolation from disturbance (Lovvorn and Kirkpatrick 1981). Typical foraging habitat includes shallow wetlands, marshes, swamps, fens, bogs, ponds, meadows, estuarine marshes, intertidal areas, and dry upland areas such as grasslands and agricultural fields. In the Interior, flooded meadows and agricultural fields provide good roosting habitat.

Roosting/staging

Observations of numerous roosting sites by Lewis (1975) and Lovvorn and Kirkpatrick (1981) indicated that roosts were characterized by level terrain, shallow water bordered by a shoreline either devoid of vegetation or sparsely vegetated, and an isolated location that reduces potential for disturbance by humans. These features are typical of roosting habitats in Burns Bog (Gebauer 1995) and at White Lake, Okanagan (Cannings et al. 1987). However, Folk and Tacha (1990) noted that open terrain at roost sites was not necessarily a critical element, but that presence of shallow water was critical.

Conservation and Management

Status

Most breeding populations of Sandhill Crane are on the provincial *Blue List* in British Columbia; however, the Georgia Depression population is on the provincial *Red List*. The Greater Sandhill Crane (*G. canadensis tabida*) is considered *Not at Risk* in Canada (COSEWIC 2002). Other subspecies have not been assessed. (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

Breeding Bird Survey results for the period 1966 to 1999 indicate significant increases in Sandhill Crane populations in the United States (4.9%/yr) and in Canada (14.4%/yr) (Sauer et al. 2000). A review and synthesis of existing information supports these trends (Johnsgard 1983; Safina 1993). Drewien and Bizeau (1974) observed that the formerly abundant crane populations in the northern Rocky Mountain States were reduced to an estimated 188–250 pairs by 1944, but since that time, have increased substantially. A low 6.7% recruitment annual rate at Malheur NWR (caused primarily by coyote depredation) was probably responsible for a decline in breeding pairs from 236 in 1975 to 168 in 1989 (Littlefield 1995b). In California, a 52% increase in breeding pairs of Greater Sandhill Crane has occurred between 1971 and 1988, whereas breeding pairs in Oregon remained stable (Littlefield et al. 1994). Lovvorn and Kirkpatrick (1981) reported a rapid increase in the eastern population of the Greater Sandhill Crane during the 1970s.

In British Columbia, population trend data are lacking, but most populations are likely stable (Fraser et al. 1999). The highest breeding densities appear to be in the Chilcotin region where recent aerial surveys found 18 nest sites in 4 days (Cooper 1996). Breeding waterbird surveys by Canadian Wildlife Service in the central Interior of British Columbia since 1987 suggest that crane populations in this area may be increasing (A. Breault, pers. comm.). Increased winter population levels in the Central Valley also suggest that populations of Greater Sandhill Cranes may be increasing in British Columbia (A. Breault, pers. comm.). The Fraser Lowland populations have declined significantly and are endangered (Gebauer 1995, 1999; Cooper 1996). South Okanagan populations have been extirpated (Cannings et al. 1987). An analysis of Breeding Bird Surveys in British Columbia for the period 1966 to 1999 did not reveal a significant trend in Sandhill Crane breeding populations (Sauer et al. 2000), however, sample sizes are likely too small to obtain significant results.

The Central Valley population of Greater Sandhill Crane (i.e., from British Columbia to California) is estimated to number between 6000 to 6800 birds (Pacific Flyway Council 1997). This population estimate is based on surveys of wintering Greater Sandhill Cranes in Oregon and northern California. Approximately half of the wintering population (i.e., between 2600 to 3400 cranes) may be breeding

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

Population	BC	AK	AB	ID	MT	NWT	OR	WA	YK	Canada	Global
Georgia Depression	S1	–	–							N?	G5T1Q
All others	S3S4B, SZN	S5B	S4B	S5B,SZN	S2N, S5B	S?	S3B	S1B,S3N	S?	N5B	G5

in British Columbia. A target population of 7500 Greater Sandhill Cranes has been set by the Pacific Flyway Management Plan (Pacific Flyway Council 1997).

Habitat trends

In most areas of the province, there have been few changes in habitat suitability or availability. Logging activities adjacent to breeding wetlands are likely the most important land use practice reducing habitat suitability in the province. In urbanized areas, such as the Burns Bog and Pitt Polder areas of the Lower Mainland, rapid urbanization and intensive agricultural regimes have reduce availability of isolated, relatively undisturbed habitats suitable for breeding.

Threats

Population threats

At Malheur NWR in Oregon, 58 of 110 nests in one year were lost to depredation (Littlefield and Ryder 1968). At Malheur NWR in 1973 and 1974, coyotes were implicated as significant predators of eggs and chicks when only two young each year were known to fledge from 236 pairs of breeders (Littlefield 1975). Eight years of predator control at Malheur NWR resulted in a rebound in the number of breeding cranes by 1993 (Littlefield 1995a). In more heavily populated areas of the Lower Mainland, road mortality and nest depredation by coyotes may be factors. Dykes and roads have increased accessibility for predators such as coyotes at Burns Bog and Pitt Polder (Gebauer 1995) and cattle trails have improved access at Malheur NWR (Littlefield and Paulin 1990).

Collisions with power lines has been described as a major mortality factor for cranes in Colorado (Brown and Drewien 1995) and North Dakota (Faanes 1987), however, this is likely not a mortality factor in British Columbia. Lead poisoning has been reported as a mortality factor (Windingstad 1988; Franson and Hereford 1994), but again, this is likely not an important mortality factor in British Columbia, especially since the use of lead shot is gradually being phased out. Windingstad (1988) found that avian cholera, avian botulism, and ingestion of mycotoxins (in waste peanuts) were the leading causes of non-hunting mortality in cranes. Hailstorms, lightning, and avian tuberculosis also killed cranes. Pesticides have generally not been implicated in eggshell thinning, reduced reproductive success, or mortality (Tacha et al. 1992).

Cold and wet spring conditions may also impact breeding success of Sandhill Cranes, as nests are susceptible to rising water levels (Littlefield et al. 1994). The Pacific Flyway Management Plan (Pacific Flyway Council 1997) identified poor recruitment as one of the major problems confronting the Central Valley population of Greater Sandhill Cranes.

Habitat threats

In the Georgia Depression, populations have declined as spreading urbanization and intensive agriculture have encroached on wetlands. In other areas of the province, land use practices such as logging up to the edge of wetlands, draining of wetlands for agriculture, and trampling of emergent vegetation by livestock have resulted in loss of habitats (Cooper 1996). Preliminary investigations by Cooper (1996) suggest that wetlands with recent nearby clearcutting in the Chilcotin region are not used for nesting by cranes.

Littlefield and Paulin (1990) found that nesting success of cranes was lower on wetlands grazed by livestock than on ungrazed wetlands. A factor possibly causing this difference included the presence of livestock trails that improved access for mammalian predators.

Most suitable habitats (e.g., bogs and swamps) in the province are of low value for timber and agricultural purposes and are in remote areas with sparse human populations. Habitats in these areas are not currently threatened.

Legal Protection and Habitat Conservation

The Sandhill Crane, its nests, and its eggs are protected in Canada and the United States under the federal *Migratory Birds Convention Act* and the provincial *Wildlife Act*. Sandhill Cranes are hunted in other jurisdictions but are closed to hunting in British Columbia.

Several nesting areas are protected in Wildlife Management Areas (e.g., Pitt Polder, Bummers Flats in the East Kootenay) or in provincial parks (e.g., Naikoon Provincial Park, Queen Charlotte Islands) (Fraser et al. 1997). Some pairs likely nest in other parks such as Stum Lake and Tweedsmuir Provincial Park. A number of new provincial parks have been announced in the south Okanagan through the Okanagan-Shuswap Land and Resource Management Plan process. The White Lake Grasslands Park (3627 ha) protects a known migratory stopover point for Sandhill Cranes.

Under the results based code, the riparian management recommendations may provide adequate protection for some wetlands particularly larger wetlands and wetland complexes.

Identified Wildlife Provisions

Wildlife habitat area

Goals

Maintain wetlands and riparian habitats that provide breeding habitat for one or more pairs of breeding cranes that are not already protected or adequately managed through the riparian management recommendations. Protect traditional roost sites used in spring.

Feature

Priority for WHA establishment is for the Red-listed Georgia Depression population. Establish WHAs at wetlands not addressed under the *Riparian Management Areas Guidebook* and where breeding is known to occur.

Size

The size of the WHA will vary depending on the size and isolation of the wetland but will generally be 20 ha (excluding wetland area). For primary migratory stopover points (e.g., Nig Creek, Kispiox Valley), a WHA should be up to 20 ha depending on particular habitat conditions of the site.

Design

The key habitat requirements for cranes include water, nesting cover and feeding meadows (Littlefield and Ryder 1968). The WHA should include a core area and management zone. The core area should include the entire stand of emergent vegetation around the wetland plus 50 m. The management zone may be between 200–350 m depending on site-specific factors such as potential disturbances, existing tree density within management zone and characteristics of adjacent upland. Design management zone to maintain seclusion of wetland and minimize disturbance. Staging or roosting sites are generally in open areas with standing water and open fields.

General wildlife measure

Goals

1. Maintain the structural integrity of emergent vegetation in and around nesting areas to provide cover and nesting habitat.
2. Maintain vegetated screen around breeding wetlands.
3. Minimize disturbance and access during the breeding season (1 April to 21 September).
4. Minimize human access to important staging areas during the migratory period (April and Sept./Oct.).
5. Restore historical water regimes to wetland areas that have been drained.

Measures

Access

- Do not develop any permanent roads within core area. Avoid road construction during the breeding season unless there is no other practicable option.
- Limit or reduce access during the breeding period and/or migration period by deactivating or gating roads.

Harvesting and silviculture

- Do not harvest during the breeding season (15 April to 15 August). Consult MWLAP for site-specific times.
- Retain at least 40% of the dominant and codominant trees within core area.

- Retain as much of the understorey trees, shrubs, and herbaceous vegetation as is practicable.

Pesticides

- Do not use pesticides.

Range

- Plan grazing to ensure that the structural integrity of stands of emergent vegetation is maintained and nests are protected from trampling. Fencing may be required in some instances.
- Do not hay wet meadows until after 25 August to prevent mortality of young.
- Do not place livestock attractants within core area.

Recreation

- Do not establish recreational facilities or trails.

Additional Management Considerations

Where water control structures are in place, do not draw down water during the breeding season; encourage landowners to keep meadows wet through July.

Do not remove beaver (*Castor canadensis*) dams where dams flood areas being used by breeding cranes.

Avoid unnecessary draining of wetlands, and changes in livestock grazing regimes.

Avoid harvesting within 800 m of breeding wetlands during the breeding season. Limit access within 400 m during the breeding season and restrict recreational activities in and around habitats used for staging and breeding during periods of use by cranes.

Where possible, ensure suitable croplands (i.e., grain) are near habitats used by migratory and staging cranes.

Maintain intact shallow freshwater wetlands, and retain riparian forests adjacent to these wetlands.

Ditching and creation of compartments and impoundments in conjunction with some wetland management practices are detrimental to crane populations. Cooper (1996) recommends that: (1) structural integrity of wetlands is maintained; (2) water use permits are controlled; (3) buffer zones are established around nesting marshes; (4) building of dykes, roads, and other structures that increase flooding risk be avoided; and (5) incentives are provided to farmers and other land users to discourage draining, dyking, or filling of nesting meadows.

Information Needs

1. Investigate the tolerance of Sandhill Cranes to logging adjacent to their wetland breeding habitats. Determination of an effective forested buffer strip is an important research question as is the effectiveness of current guidelines to protect riparian areas (e.g., *Riparian Management Area Guidelines*).
2. Concentrated inventory of potentially core breeding areas in the Chilcotin-Cariboo, Queen Charlotte Islands (e.g., Naikoon Provincial Park), northern Vancouver Island, and northeastern British Columbia using standardized methods are required to estimate breeding population size.
3. Determining the breeding range of the three subspecies in British Columbia would be of particular management interest for the Pacific Flyway Management Plan.

Cross References

Nelson's Sharp-tailed Sparrow, Pacific Water Shrew

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Lewis's Woodpecker

Melanerpes lewis

Original[1] prepared by Martin Gebauer

Species Information

Taxonomy

The Lewis's Woodpecker is currently placed in the genus *Melanerpes*, a genus with 21 species (Tobalske 1997). It has often been placed in the monotypic genus *Asyndesmus* (Bock 1970; AOU 1983). Five other *Melanerpes* species occur in North America (north of Mexico): Red-headed Woodpecker (*M. erythrocephalus*), Acorn Woodpecker (*M. formicivorus*), Golden-fronted Woodpecker (*M. aurifrons*), Red-bellied Woodpecker (*M. carolinus*), and Gila Woodpecker (*M. uropygialis*) (NGS 1999). The Lewis's Woodpecker is considered to be closely related to the Red-headed Woodpecker and possibly the Acorn Woodpecker (Tobalske 1997). No subspecies of Lewis's Woodpecker are recognized (AOU 1983).

Description

The upperparts of adult Lewis's Woodpecker are a glossy greenish-black except for a narrow grey collar. The face is a dark red and the breast is grey, shading into rose on the abdomen, flanks, and sides. Young are similar to adults but lack the red face and grey collar. In flight, its overall dark appearance, large size, and slow, steady wingbeats give it a crow-like appearance (Bent 1939). Flight is not undulating like that of other woodpeckers (e.g., genus *Picoides*) (Godfrey 1986; NGS 1999).

Distribution

Global

The Lewis's Woodpecker is restricted to North America, breeding from southern British Columbia through the western United States to California and southern New Mexico, and east to western Oklahoma and Nebraska (Bent 1939; Tobalske 1997). Its distribution appears to be closely related to the presence of ponderosa pine (*Pinus ponderosa*) (Tobalske 1997).

Lewis's Woodpeckers winter within the southern portion of their breeding range as far north as southwestern Oregon, central Utah, and central Colorado. It winters south of its breeding range to northern Baja California Norte, Chihuahua, and Sonora, Mexico (Howell and Webb 1995; Tobalske 1997).

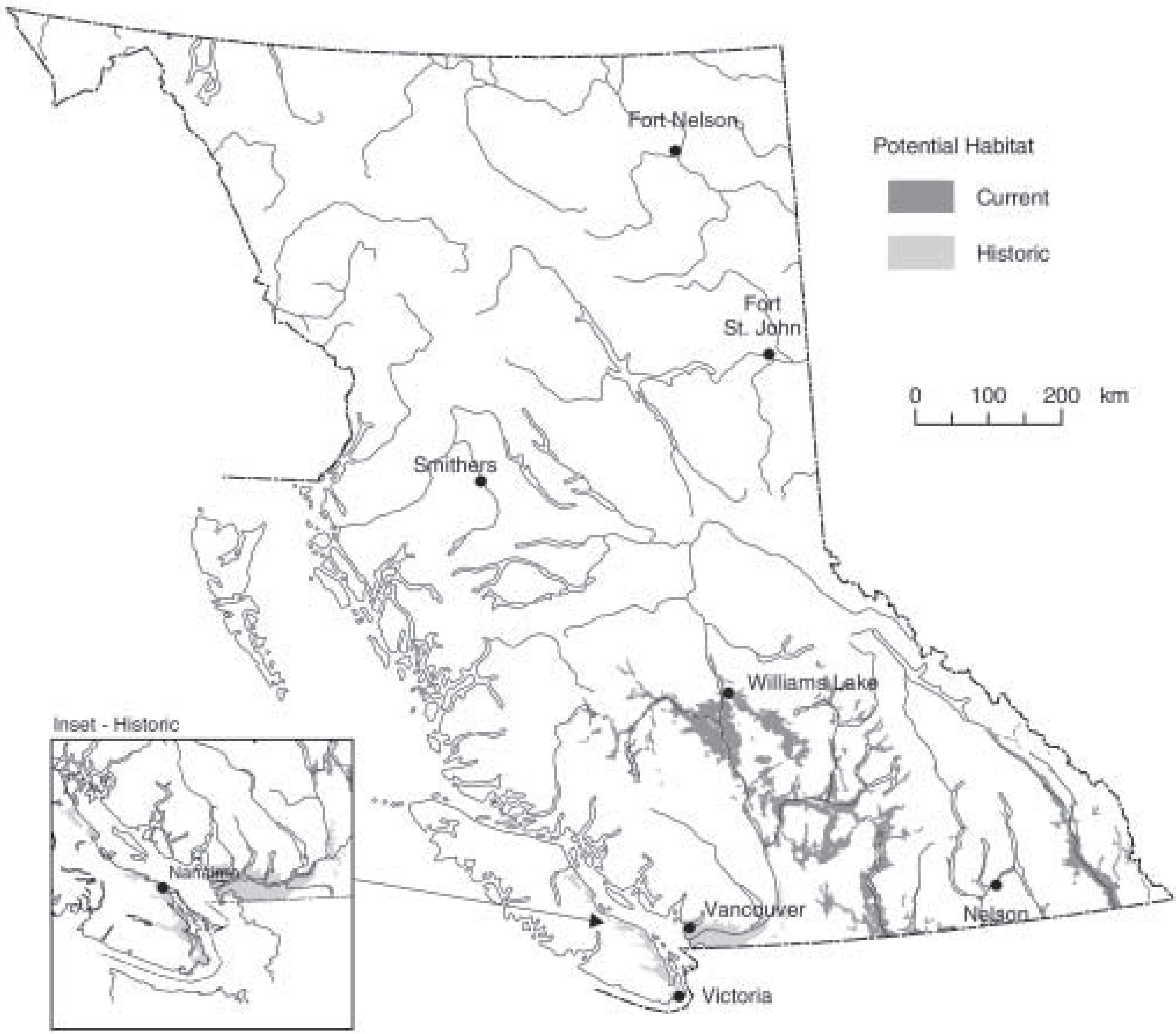
British Columbia

The Lewis's Woodpecker breeds locally throughout the southern Interior of British Columbia from the Similkameen Valley, east to the East Kootenay (e.g., Invermere south to Newgate and the Tobacco Plains) and north to the Chilcotin-Cariboo area (Campbell et al. 1990, Cooper and Beauchesne 2000). It is most abundant in the south Okanagan (Cannings et al. 1987). Breeding has been documented in Golden and Revelstoke, but these populations appear to have been extirpated (Cooper et al. 1998). Individuals have been seen recently in mature cottonwood stands in the Robson Valley of east-central British Columbia although breeding there has not yet been documented (L. Ingham, pers. comm.). Lewis's Woodpecker was a former abundant breeder in the Lower Mainland and on southeastern Vancouver Island between the 1920s and 1940s, when extensive clearcuts with abundant snags were available. Breeding in this region was last confirmed in 1963 (Campbell et al. 1990).

A few birds winter in the south Okanagan with the centre of abundance from Vaseux Lake to Summerland. In winter it appears to be restricted to residential areas and orchards (Cannings et al. 1987).

1 Volume 1 account prepared by T. Manning

Lewis's Woodpecker
(Melanerpes lewis)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Forest region and districts

Coast: Chilliwack, South Island (historical)

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, possibly Columbia, Headwaters, Kamloops, Kootenay Lake, Okanagan Shuswap, Rocky Mountain

Ecoprovinces and ecosections

CEI: FRB, possibly CAB, CAP, CCR, CHP, QUL

COM: FRL (historical)

GED: LIM, NAL (historical)

SIM: CCM, EKT, ELV, EPM, MCR, SCM, SFH, SPK, SPM, UCV

SOI: GUU, NIB, NOB, NOH, NTU, OKR, PAR, SCR, SHB, SOB, SOH, STU, THB, TRU

Biogeoclimatic units

BG: xh1, xh2, xh3, xw, xw1, xw2

ICH: dw, mk1, mw2, mw3, xw

IDF: dk1, dk2, dk3, dk4, dm, dm1, dm2, dw, mw1, mw2, un, xh1a, xh2a, xm, xw, xw2

PP: dh1, dh2, xh1, xh2

MS: un, dk

SBPS: mk, xc

Broad ecosystem units

AB, AC, BS, CR, DF, DL, DP, OV, PP, RR, SS, UR, WR

Elevation

In British Columbia, the Lewis's Woodpecker has been observed nesting at elevations ranging from 250 to 1160 m (Campbell et al. 1990; Cooper and Beauchesne 2000). All nests above 1000 m were in burns (Cooper and Beauchesne 2000).

Life History

Diet and foraging behaviour

The diet of Lewis's Woodpeckers varies with the seasonal abundance of food items, but includes primarily free-living (i.e., not wood-boring) insects, acorns and other nuts, seed and berries, and wild and agricultural fruit (Sherwood 1927; Bent 1939; Bock 1970; Cannings et al. 1987; Tobalske 1997). Insects taken include ants, butterflies, bees, wasps, beetles, crickets, and grasshoppers (Cannings et al. 1987; Tobalske 1997). Succulent fruits taken include apples, cherries, peaches, Saskatoon (*Amelanchier alnifolia*), hawthorn (*Crataegus* spp.), dogwood (*Cornus* spp.), elderberry (*Sambucus* spp.), and sumac (*Rhus* spp.) (Cannings et al. 1987; Tobalske 1997).

During the breeding season, Lewis's Woodpeckers primarily forage by hawking insects in the air, but will also glean insects from tree trunks, branches, bushes, and the ground (Bock 1970; Short 1982 Raphael and White 1984). Extended feeding flights of greater than 30 minutes have been observed (Bent 1939; Beauchesne, pers. obs.). Snags or dead-topped trees and human-made structures such as telephone poles and fence posts that provide an open view are used for perching when hawking insects. Foraging substrates in the Sierra Nevada were primarily snags (i.e., 66% of 88 foraging bouts), with ground and live trees used to a lesser extent (Raphael and White 1984). The most common position used on the tree was the trunk (i.e., 68%) (Raphael and White 1984). Although no studies in British Columbia have specifically investigated diet, free flying insects and fruits, especially berries, seem to be the most important food items during breeding season (Cannings et al. 1987; Beauchesne, pers. obs.).

Lewis's Woodpeckers also collect and store nuts, such as acorns, primarily in the winter, and in some areas, corn in the fall (Hadow 1973; Vierling 1997). On several occasions in the Penticton and Summerland areas, it has been observed storing acorns of the introduced red oak (*Quercus rubra*) in the cracks of power poles (Cannings et al. 1987). Interestingly, Lewis's Woodpeckers first husk acorns, often cutting them into pieces, before storing them (Bent 1939; Ehrlich et al. 1988). Oak trees, cottonwood, and cracked telephone poles are some of the principal storage areas reported (Tobalske 1997). In the East Kootenay trench, during the breeding season, birds were observed caching beetles in the bark of ponderosa pine and in the cracks of utility poles (Beauchesne, pers. obs.).

Reproduction

Dates for 69 clutches in British Columbia ranged from 16 April to 27 June, with 53% recorded between 23 May and 11 June (Cannings et al. 1987; Campbell et al. 1990). Average size of 30 clutches ranged from two to eight eggs with 63% having four to six eggs (Campbell et al. 1990). Bent (1939) has reported clutch sizes of up to nine eggs. Average incubation period ranges from 13 to 14 days (Ehrlich et al. 1988) with up to 16 days reported (Tobalske 1997). Dates for 165 broods in British Columbia ranged from 5 May to 3 August with 51% recorded between 12 June and 6 July (Campbell et al. 1990). Sizes of 28 broods ranged from one to five young with 89% having two to four young (Campbell et al. 1990). Fledgling period ranges from 28 to 34 days (Ehrlich et al. 1988; Tobalske 1997).

Lewis's Woodpeckers have been reported to be colonial in some areas (Currier 1928; Linder and Anderson 1998). Cooper and Beauchesne (2000) found three active nests in a live ponderosa pine near Newgate, in the East Kootenay in 1997. In 1998, the same tree harboured two active Lewis's Woodpecker pairs and one American Kestrel pair. The Lewis's Woodpeckers from this nest tree primarily travelled to forage within the open burn on the edge of Lake Koocanusa (Beauchesne, pers. obs). Concentrations of Lewis's Woodpeckers have also been found in the Finlay Creek Burn (31 nesting pairs) and the Dutch Creek burn (seven nesting pairs) of the East Kootenay Trench (Cooper and Gilles 1999).

Site fidelity

Site fidelity is difficult to determine because very few researchers have banded these birds, marking individuals (Tobalske 1997). However, the same cavities are often used in successive years (Bent 1939; Tobalske 1997). In Wyoming, 37% of nest cavities found in 1993 were reused in 1994 (Linder and Anderson 1998). In the East Kootenay Trench, 60% of nest cavities found in 1997 were reused in 1998 (Cooper and Beauchesne 2000). In addition, where cavities had been destroyed or removed between breeding seasons, a pair was often found nesting nearby (Cooper and Beauchesne 2000).

Home range

Little is known of the home range of Lewis's Woodpeckers. Adults defend the immediate vicinity of nesting trees and mast stores in fall and winter (Hadow 1973; Tobalske 1997). In the Blue Mountains of Washington and Oregon, territory size of 6.1 ha/pair has been reported (Thomas et al. 1979). In the East Kootenay Trench, birds were observed travelling more than 1 km from their nest to forage, suggesting that some home ranges may be extensive (Beauchesne, pers. obs.).

Movements and dispersal

Most birds in British Columbia are migratory arriving within the first 2 weeks of May, although early arrivals appear in mid-April. Large flocks gather in late summer, wandering through foraging habitats in their local ranges. Peak autumn movement is between late August and early September. Few birds remain after the end of September (Campbell et al. 1990). One notable migration of Lewis's Woodpeckers was observed on 7 September 1971, when 42 birds in groups of two and three, moved past McIntyre Bluffs (Cannings et al. 1987).

Lewis's Woodpeckers wander irregularly, having been reported as far north as Masset on the Queen Charlotte Islands and at Takla Lake in the central Interior of British Columbia (Campbell et al. 1990).

Habitat

Structural stage

2: herb – foraging for ants, beetles and other insects
3a: low shrub – shrub stage for foraging when insects are abundant
3b: high shrub – possibly used for foraging when insects are abundant
5: immature forest – particularly in black cottonwood stands
6: mature forest – black cottonwood, ponderosa pine and oak stands
7: old-growth forest – black cottonwood, ponderosa pine and oak stands

Important habitats and habitat features

Nesting

Typical breeding habitat in the interior of British Columbia includes deciduous groves (e.g., mature cottonwood stands), open ponderosa pine forests, recent burns, sagebrush/pine/bunchgrass grasslands, agricultural areas, and urban environments (Campbell et al. 1990; Cooper et al. 1998; Cooper and Beauchesne 2000).

Good breeding habitat is characterized by an open canopy (e.g.,<25% crown closure), the availability of a suitable dead or dying tree (>30 cm dbh) for a nesting site, and understorey vegetation that provides an abundant supply of insects. Where closed canopy riparian stands are used, trees at the edge of the stand are usually used for nesting (Fraser et al. 1999). In the East Kootenay, a high density (i.e., 59% of 85 nests) of breeding Lewis's Woodpeckers were found in areas that were burned by stand-destroying fires (i.e., characterized by open space with a few remaining snags) between 13 and 28 years ago (Cooper and Beauchesne 2000). Bock (1970) indicated that burns <10 years and >40 years are likely of low use because of successional factors. However, in southwestern Idaho, Saab and Dudley (1998) found a high density of Lewis's Woodpecker, 2–4 years after a stand-destroying fire, in areas that had been salvage logged. In Wyoming, 98% of Lewis's Woodpecker nests studied by Linder and Anderson (1998) were found within burned stands despite these stands comprising only 26% of the 11 100 ha study area.

In Colorado, Vierling (1997) found that mature cottonwood forests were critical for breeding and mast storage, whereas little breeding was evident in ponderosa pine forests; the author suggests this is probably due to a lack of suitable ponderosa pine forest in that area. In the Okanagan, Cannings et al. (1987) reported a high percentage of documented breeding Lewis's Woodpeckers in black cottonwood (*Populus balsamifera*), but attribute this partially to observer bias. In contrast, in the East Kootenay, Cooper and Beauchesne (2000) found low numbers of breeding pairs in black cottonwood stands despite the relative abundance of this habitat in some areas. This may have been because riparian cottonwood stands tend to be bordered by dense conifer stands rather than the open grasslands found in the Okanagan Valley and Thompson Basin (Cooper et al. 1998). In the Cariboo-Chilcotin, Lewis's Woodpecker use wide-spaced large diameter Douglas-fir (*Pseudotsuga menziesii*) trees in the grasslands (grassland/Douglas-fir ecotone), and mature cottonwood groves. The different use of forest types may indicate that other structural components are more important than forest type for breeding habitat selection.

Sousa (1983) suggests that good Lewis's Woodpecker breeding habitat is positively correlated with increased shrub density, which supplies an abundance of insects (<25% shrub closure has no value, from 25 to 50% there is an increase in value, and >50% or greater is optimal). However, recently other researchers have found that Lewis's Woodpeckers selected breeding habitat with much lower shrub densities (i.e., 16.1% in Wyoming and 13.4% in California; Linders and Anderson 1998). This is more consistent with the habitat in the East Kootenay Trench, where the average percentage of cover by shrubs at nesting sites was 16.5% (*n* = 109; range 0–90%) (S.M. Beauchesne, unpubl. data). Most of the sites with a high shrub density (*n* = 11, average density 40%) were in the Dutch Creek burn, an area considered to be of limited future suitability to Lewis's Woodpecker because of conifer regeneration (Cooper and Gilles 2000). Excluding the Dutch Creek burn data, the shrub closure for the East Kootenay Trench was 14.4% (S.M. Beauchesne, pers. comm.).

Lewis's Woodpeckers nest in living and dead deciduous and coniferous trees in British Columbia with ponderosa pine (47% of 215 nests) and black cottonwood (33%) the most common nest trees reported (Campbell et al. 1990). Use of human-made structures such as utility poles (eight records from 215 nests), fence posts (one record from 215 nests; Campbell et al. 1990), and buildings (one record of a cavity in roof of a house; Beauchesne, pers. obs.) is also possible. Other tree species used in the Interior included domestic cherry and apple, ornamental maple, Douglas-fir, western larch (*Larix occidentalis*), trembling aspen (*Populus tremuloides*), alder, (*Alnus rubra*) paper birch (*Betula papyrifera*), ornamental willow, elm, and Lombardy poplar (Cannings et al. 1987; Cooper and Beauchesne 2000). Trees previously used for nesting in coastal areas included Garry oak (*Quercus garryana*) and bigleaf maple (*Acer macrophyllum*) (Cooper et al. 1998). Garry oak (known as Oregon white oak in the United States) is still used to a large extent in Wasco County, Oregon (Galen 1989). In the Blue Mountains of Oregon and Washington, Lewis's Woodpecker used 72% cottonwood, 12% ponderosa pine (*Pinus ponderosa*), 10% juniper, 4% willow, and 2% fir for nesting ($n = 49$) (Thomas et al. 1979).

Lewis's Woodpeckers can excavate their own cavities, but will reuse old Lewis's Woodpecker, Northern Flicker (*Colaptes auratus*), or Hairy Woodpecker (*Picoides villosus*) nest holes or natural cavities (Tobalske 1997). Live trees and dead trees with heartrot provide suitable nesting trees. Softer snags are preferred.

In British Columbia, nest heights ($n = 212$) ranged from 1.0 to 30.5 m with most nests (64%) recorded between 3.5 and 9.0 m (Campbell et al. 1990). In 1998, a nest cavity in a 1.6 m stump in the East Kootenay was only 60 cm above the ground, the lowest nest cavity height reported for Lewis's Woodpecker (Cooper and Beauchesne 2000).

The characteristics of Lewis's Woodpecker nest trees vary between locations (see Table 1), and dbh varies between nest tree species (see Table 2).

Table 1. Characteristics (mean ± SD) of Lewis's Woodpecker nests trees

Location	Species	Citation	*n*	dbh (cm)	Height (m)	Nest height (m)
Colorado	Cottonwood	Vierling 1997	47	112.6 ± 38.8	20.4 ± 5.2	11.1 ± 3.4
Wyoming	Ponderosa pine	Linder 1994	35	47.8 ±8.4	10.6 ± 3.0	7.5 ± 2.7
Sierra Nevada	Pine/fir forests	Raphael and White 1984	37	66.5		
British Columbia	Ponderosa pine and cottonwood	Campbell et al. 1990	215			1.0–30.0 range
Oregon	Oregon white oak and ponderosa pine	Galen 1989	53	66 ± 20.8		
British Columbia	Ponderosa pine and Douglas-fir	Cooper and Beauchesne 2000	85	52 ± 19.1		

Table 2. Dbh[a] of Lewis's Woodpecker nest trees by species in the eastern foothills of Mount Hood in Oregon (Galen 1989) and in the East Kootenay of British Columbia (Cooper and Beauchesne 2000)

Tree Species	Oregon		British Columbia	
	n	dbh (cm)	*n*	dbh (cm)
Ponderosa pine	22	75.6 ± 19.2	34	59.2 ± 21.9
Douglas-fir	5	72.1 ± 16.2	30	48.3 ± 13.6
Black cottonwood	3	65.2 ± 21.6	3	71.0 ± 33.0
Oregon white oak	23	56.1 ± 19.8		
Birch			4	47.5 ± 13.4
Aspen			6	34.2 ± 11.3
Western larch			3	47.0 ± 9.9

a Mean ± SD.

Foraging

During the breeding season in British Columbia, foraging areas include breeding habitats, open forests and valley bottoms, deciduous groves near lakes and streams, burns, logged areas, agricultural habitats such as orchards and farms, rural gardens, and urban areas. In British Columbia in winter, foraging is generally restricted to residential areas, orchards, and mature cottonwood groves (Cannings et al. 1987).

Broken-topped or large-limbed living or dead trees are used as hawking perches.

Conservation and Management

Status

The Lewis's Woodpecker is on the provincial *Blue List* in British Columbia. It is considered a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	WA	ID	MT	Canada	Global
S3B, SZN	SH	S3B, SZN	S4B, SZN	S4B, SZN	N3	G4

Trends

Population trends

Breeding Bird Survey results for the period 1966 to 1999 indicate a significant decline (-2.3%/yr) in Lewis's Woodpecker populations across North America (Sauer et al. 2000). Declines of -2.2% were observed in western North America. Significant declines were noted in Montana (-5.2%) and Washington (-8.4%) (Sauer et al. 2000). Sauer et al. (2002) did not report a significant trend in British Columbia for the same period; however, sample sizes were likely too small to obtain significant results. Cooper et al. (1998) and Fraser et al. (1999) report that long-term population declines have been documented in British Columbia and that populations may still be declining. Once abundant, populations on southeastern Vancouver Island and near Vancouver have been extirpated (Campbell et al. 1990).

Population size of Lewis's Woodpecker in the province was estimated to be a maximum of 600 pairs in 1990, but this estimate may have been conservative because some areas had not yet been surveyed (Fraser et al. 1999). For example, based on inventory work in 1997 and 1998 in the East Kootenay Trench, this region has a population estimate of 100–150 pairs (Cooper and Beauchesne 2000).

Habitat trends

Potential suitable habitat is undoubtedly declining as stands of mature ponderosa pine, Douglas-fir, and black cottonwood are harvested for timber, urban development, and firewood. Stands of old black cottonwood along the South Thompson River, east of Kamloops, have been severely impacted by cattle activity, urban development, and changing agricultural practices (Cooper et al. 1998). Helicopter logging of mature ponderosa pine still occurs in some areas where steep terrain and other access issues prevented their removal in the past. Some low-lying areas in the East Kootenay have been flooded by hydroelectric reservoirs (Cooper et al. 1998).

Intensive grazing may result in elimination of brushy or grassy forest understoreys, that may be important to Lewis's Woodpeckers. Forest fire suppression has resulted in encroachment by regenerating conifers into open ponderosa pine forests, which has reduced suitable habitat for Lewis's Woodpeckers.

Threats

Population threats

Competition with European Starlings may be a problem in some areas, but Lewis's Woodpeckers appear to be more successful in competing with starlings than other *Melanerpes* woodpeckers such as the Red-bellied Woodpecker (Cannings et al. 1987; Ingold 1994). Vierling (1998) recorded 78 inter-specific interactions between starlings and Lewis's

Woodpeckers during 418 hours of monitoring. Of the 59 Lewis' Woodpecker pairs, only one lost its nest cavity to starlings. In the Okanagan and the East Kootenay Trench, starlings and Lewis's Woodpeckers seem to be able to coexist, having been observed nesting in the same habitat, occasionally sharing a nest tree (Cannings et al. 1987; Cooper and Beauchesne 2000). In contrast, Sorenson (1986) found a correlation between the rapid increase of starlings in Salt Lake City and the rapid decline of Lewis's Woodpeckers. It is possible that the effects of competition depend on resource availability (i.e., number of cavities) and population size of the competitors (i.e., if Lewis's Woodpecker are vastly outnumbered by starlings and cavities are scarce, the energetic cost of competition may be too great).

Collisions with cars may be a cause of mortality in some areas (Tobalske 1997). Both members of a pair nesting close to Highway 95 were found dead by the road in 1997 (Cooper and Beauchesne 2000).

Habitat threats

Fire suppression in the Okanagan and other interior areas has resulted in dense stands of ponderosa pine and Douglas-fir in forest understoreys, making some stands unsuitable for Lewis's Woodpecker (Cooper et al. 1998). Vierling (1997) found that Lewis's Woodpeckers in southeastern Colorado avoided dense stands of trees at all times of the year. Other factors such as grazing, logging, and possibly climate change have resulted in many more younger and smaller trees, fewer older and larger trees, accumulation of fuel loads, reduced herbaceous production, and associated changes in ecosystem structure, fire hazard, and wildlife fauna (Covington and Moore 1994).

Loss of nest trees through logging and firewood collection is a significant threat. In coastal areas of southwestern British Columbia, the cutting of snags for firewood and as a WCB safety requirement for the Forest Service may have contributed to the decline and eventual extirpation of Lewis's Woodpeckers (Campbell et al. 1990). Removal of Garry Oak on Vancouver Island likely resulted in declines in numbers there (Fraser et al. 1999).

Use of insecticides and pesticides in orchards and gardens may reduce insect populations, an important food resource during the breeding season.

Legal Protection and Habitat Conservation

The Lewis's Woodpecker, its nests, and its eggs are protected in Canada and the United States under the *Migratory Birds Convention Act* and in British Columbia under the provincial *Wildlife Act*.

Several breeding sites are protected in provincial parks, ecological reserves, and wildlife management areas. According to MELP (1998), only 8% (i.e., 7731 ha) of potentially suitable Lewis's Woodpecker habitat in the south Okanagan is currently designated as conservation lands. Remaining suitable lands are found on Crown land (34 1999 ha; 37%); Indian Reserves (22 110 ha; 24%); and private land (27 975 ha; 30%). A number of new provincial parks have been announced in the south Okanagan through the Okanagan-Shuswap Land and Resource Management Plan process. Some of the more important parks for Lewis's Woodpecker include White Lake Grasslands and South Okanagan Grasslands.

The riparian and biodiversity guidelines under the results based code, particularly recommendations for wildlife tree retention, may partially address the requirements of this species. The feasibility of using the wildlife tree retention area recommendations or the wildlife habitat feature designation should be considered prior to establishing a WHA for this species and should be used to manage for individual pairs.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- ❖ Maintain open forests, dominated by ponderosa pine, black cottonwood, or Douglas-fir, with some large snags and recruitment trees.
- ❖ Provide naturally vegetated linkages between riparian areas, semi-open forest, and reserve areas of similar quality.

- ❖ Consider the relative location and proximity of other preferred habitats (e.g., recent burns, partially logged areas showing low crown closures and desirable habitat attributes such as snags and large hardwoods, orchards, crop fields, or pastures).
- ❖ Since this species is largely dependent on wildlife trees, it is best managed through the wildlife tree retention objectives established within landscape level plans. Blocks should be assessed to identify potentially suitable WTR areas. Table 3 provides recommendations for wildlife tree retention objectives for this species.
- ❖ It is recommended that salvage not occur in WTR areas established to provide habitat for this species. In addition, these areas should be designed to include as many suitable wildlife trees as possible and maintained over the long term.

Wildlife habitat area

Goal

Maintain suitable nesting habitat for multiple pairs.

Feature

Establish WHAs over breeding aggregations of three or more pairs.

Size

Typically between 5 and 50 ha but will depend on area of suitable habitat.

Design

The WHA should contain open mature or old growth ponderosa pine or Douglas-fir forests, preferably with <25% canopy closure, with presence of large diameter dead or live snags (preferably ≥45 cm dbh; minimum 30 cm dbh) OR mature deciduous stands (e.g., paper birch, trembling aspen, and black cottonwood) with variable canopy closure (range from approximately 5–80% with presence of large trees (preferably ≥45 cm dbh; minimum 30 cm dbh).

General wildlife measure

Goals

1. Provide an adequate supply of large diameter live and dead wildlife trees suitable for foraging and nesting.
2. Maintain an open canopy.
3. Maintain the integrity of nesting habitat.
4. Maintain shrub cover.

Measures

Access

- Do not construct roads unless there is no other practicable option.

Harvesting and silviculture

- Do not harvest or salvage mature timber. When harvesting is approved, follow the measures below.

Table 3. Preferred wildlife tree patch features for the Lewis's Woodpecker

Attribute	Characteristics
Size (ha)	variable; may be quite small (1 ha)
Location	if possible, on west side of valleys; proximity to large open areas important
Tree features	large dbh; evidence of heartrot infection or broken tops or limbs
Tree species	ponderosa pine; black cottonwood; Douglas-fir
Tree size (dbh)	in general: 55–80 cm; specifically: 66–87* cm ponderosa pine, 68–96* cm cottonwood, 52–66* cm Douglas-fir; in the absence of trees with the preferred dbh, trees ≥30 cm may be retained for recruitment
Wildlife tree class	2–4 for ponderosa pine; 4–7 for Douglas-fir (a mix would be ideal, but preference would be for lower end of decay range to maximize current suitability and longevity)

* Weighted mean pooled S.D.

- Protect and retain all ponderosa pine and black cottonwood live and dead trees ≥30 cm dbh for nesting, perching, and foraging.
- Maintain at least six standing dead trees per ha. Where it is not possible to retain six ≥45 cm, use the largest available. The highest practical density of snags is preferred. Hazardous snags or trees can be incorporated into group reserves (plan as no-work zones if appropriate); otherwise maintain snags within the operational setting as described in the *Wildlife/Danger Tree Assessor's Course Workbook*. Use partial cutting silvicultural systems to maintain widely spaced (<25% canopy cover) late seral ponderosa pine and Douglas-fir.
- Topping large diameter snags may be appropriate in areas where standing dead trees are few.
- Additional potential nest sites in intensely managed stands may be provided by leaving some high-cut (5 m in height) stumps of large (≥45 cm dbh) ponderosa pine or black cottonwood.

Pesticides

- Do not use pesticides.

Range

- Limit browse utilization by livestock to no more than 10%.

Additional Management Considerations

Open forests resulting from regularly occurring burns provide prime nesting and foraging habitat for Lewis's Woodpeckers (Cooper and Beauchesne 2000). Naturally occurring fire regimes in the ponderosa pine and Douglas-fir biogeoclimatic zones should be encouraged, and where possible, fire suppression should be minimized. The use of prescribed burning is a potentially useful habitat management tool.

A high potential for habitat enhancement exists through a combination of mechanical removal of regenerating conifers and selective logging of mature timber. Planting of suitable "snags" in open habitats where natural snags are absent may be beneficial as well.

Maximize the number of snags retained in suitable habitats.

Implement protection measures to reduce the risk of stand-replacing fire. Encourage ground-fires that keep regenerating ponderosa pine and Douglas-fir in check but do not kill mature trees.

Use prescribed burning to create semi-open parkland habitats with sufficient grassland understorey to provide habitat for an abundance of insects, and presence of some snags for nesting.

Information Needs

1. Impacts of tree encroachment into open ponderosa pine habitats, and the role of fire suppression.
2. Information on the effect of cattle grazing on habitat quality and the role that starlings play in Lewis's Woodpecker population levels.
3. Inventories in the Fraser River Basin and the Pavilion Ranges ecosections where populations are poorly documented.

Cross References

Bighorn Sheep, Fringed Myotis, "Great Basin" Gopher Snake, "Interior" Western Screech-Owl, Racer, White-headed Woodpecker, ponderosa pine/ bluebunch wheatgrass – silky lupine

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White-headed Woodpecker

Picoides albolarvatus

Original[1] prepared by Martin Gebauer

Species Information

Taxonomy

The White-headed Woodpecker is currently placed in the genus *Picoides*, a genus poorly understood phylogenetically and subject to frequent revisions over the years (Garrett et al. 1996). Eight other *Picoides* species occur in North America: Ladder-backed (*P. scalaris*), Red-cockaded (*P. borealis*), Nuttall's (*P. nuttallii*), Strickland's (*P. stricklandi*), Downy (*P. pubescens*), Hairy (*P. villosus*), Three-toed (*P. tridactylus*), and Black-backed (*P. arcticus*) woodpeckers (AOU 1998).

Two subspecies of White-headed Woodpecker are recognized: one occurring in the mountains of southern California (*P. albolarvatus gravirostris*), and the other from British Columbia to the Sierra Nevada in central California (*P. albolarvatus albolarvatus*) (Garrett et al. 1996; Cannings 1998).

Description

The White-headed Woodpecker is unique among North American woodpeckers in having entirely black body plumage and tail, with only the face, throat, crown, and large patch at the base of the primaries white. Males have a red patch at the back of the head; juvenile males have a variable patch of red on the crown (Garrett et al. 1996; NGS 1999).

Clark's Nutcracker (*Nucifruga columbiana*), a corvid with pale grey head, and woodpecker-like bill and behaviour, is occasionally mistaken for the White-headed Woodpecker (Cannings 2000).

Distribution

Global

The White-headed Woodpecker is restricted to western North America, ranging from extreme southcentral British Columbia southward, primarily east of the Cascades, to southern California (Garrett et al. 1996).

British Columbia

The White-headed Woodpecker is a very rare resident in the Okanagan Valley from Naramata south, and occasionally resides in the Similkameen Valley, Grand Forks area, and the Kootenays (Weber and Cannings 1976; Cannings et al. 1987; Campbell et al. 1988; Campbell et al. 1990). Sightings in suitable habitat have also been reported from Lytton, Manning Park, Bummers Flats north of Cranbrook, and south of Golden but have not been substantiated by detailed descriptions or photos (Weber and Cannings 1976; Campbell et al. 1990).

Forest region and districts

Southern Interior: Arrow Boundary, Cascades, (incidental – Kootenay Lake), Okanagan Shuswap

Ecoprovinces and ecosections

SIM: SCM, SFH

SOI: OKR, SOB, SOH, NOB, NOH, (incidental – NTU, STU, THB)

Biogeoclimatic units

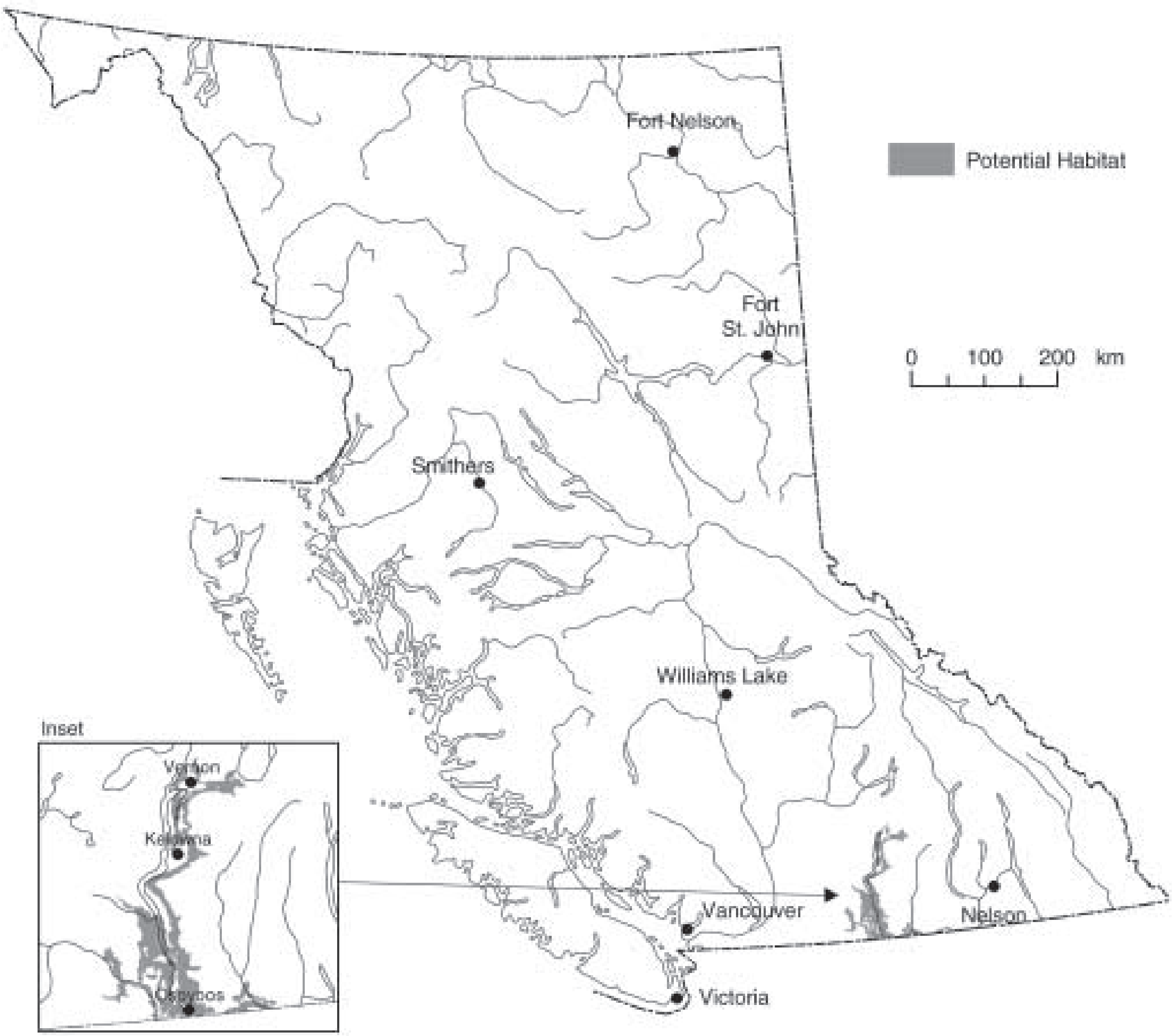
BG: xh (breeding)

ESSF: mc, mk, mm, mv, mw (very incidentally if at all—only 2% of sightings)

ICH: dw (very incidentally if at all—only 2% of sightings)

1 Volume 1 account prepared by T. Manning and V. Stevens.

White-headed Woodpecker
(Picoides albolarvatus)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

IDF: dk, dm, xh, xm, xw (very incidentally)

MS: dc, xk (very incidentally if at all—only 2% of sightings)

PP: xh (breeding)

Broad ecosystem units

DP, PP, (very rarely uses DL, ER, EF, and LP in BC; not common in DF)

Elevation

350 to 1300 m; rarely seen above 1000 m

Life History

Diet and foraging behaviour

In early summer, the White-headed Woodpecker forages for insects mainly on the lower portions of large, live ponderosa pine (*Pinus ponderosa*) trees in the puzzle bark stage (>60 cm dbh) (Dixon 1995b; Garrett et al. 1996). However, insects (ants, wood-boring beetles, spiders, fly larvae) make up a small proportion of the diet relative to other *Picoides* woodpeckers (Ligon 1973; MELP 1998). For most of the year, White-headed Woodpecker forages primarily for seed in the cones of ponderosa pine. Ponderosa pine seeds are generally only available in late summer and fall, except in years with heavy cone crops (Dahms and Barrett 1975). Pine seeds are a major source of food throughout the range of White-headed Woodpecker (Bent 1939; Curtis 1948; Koch et al. 1970; Ligon 1973).

When foraging for insects on conifer trunks or branches, the White-headed Woodpecker flakes and chips bark away rather than striking the wood directly like some woodpeckers (Ligon 1973). It generally flies to the bottom of a tree and works its way to the top while feeding (Bent 1939). Other foraging behaviours are varied and include gleaning foliage in terminal needle clusters (Ligon 1973; Raphael and White 1984), scratching bark loose with its feet (Ligon 1973), feeding on stalks of great mullein (*Verbascum thapsus*) (Weber and Cannings 1976), and visiting suet feeders (Cannings et al. 1987). Compared with the Hairy Woodpecker, the White-headed Woodpecker fed more on living trees, consistent with their habit of gleaning rather than drilling and excavating (Morrison and With 1987).

Reproduction

The White-headed Woodpecker is a primary excavator, making its cavities in dead or dying trees, with a preference for large ponderosa pine (usually >60 cm dbh) (Thomas 1979; Dixon 1995a; Dixon 1995b). Typically a new nest cavity is excavated each year but in exceptional cases a cavity may be reused (Garrett et al. 1996).

In British Columbia, eggs have been found in nests from mid-May to mid-June. Clutch size ranges from three to nine eggs (av. 4–5). The incubation period usually lasts for 14 days. In British Columbia, young have been recorded at nests from 30 May to 16 July (Campbell et al. 1990). Nestlings may fledge as early as late June. Typically there is one brood per breeding season.

Site fidelity

Pairs of White-headed Woodpecker do not exhibit much site fidelity from year to year in British Columbia, often breeding at a site for only 1–2 years and then moving on (Cannings 2000). No information is available on where breeding pairs move and whether the same breeding areas are reused.

Home range

No information on home range or territory size of White-headed Woodpecker exists for British Columbia. Breeding territories averaged 104 ha in continuous old-growth pine forest and 321 ha in fragmented sites in central Oregon (Garrett et al. 1996), suggesting that breeding territories in British Columbia, where much of remaining ponderosa pine forest is fragmented, may be larger than in other areas of the range.

Movements and dispersal

The White-headed Woodpecker is at the northern limit of its distribution in the southern Interior. It is considered a year-round resident in British Columbia and has a relatively even distribution of observations by month (Weber and Cannings 1976; Cannings et al. 1987). Because of the small resident population and few sightings in British Columbia, seasonal movement and dispersal patterns are not known, although, presumably young birds wander in search of breeding areas. It is likely that populations in the Okanagan could increase after a year of high breeding success in Washington State as young birds disperse northwards. Records of this species at higher elevations and outside the Okanagan Valley are likely the result of these dispersal movements.

Habitat

Structural stage

6: mature forest
7: old forest

Important habitats and habitat features

The White-headed Woodpecker prefers mature and old forests (i.e., structural stage classes 6–7) (Mannan and Meslow 1984). These forests are structurally complex, typically contain snags and coarse woody debris at all stages of decomposition, and have open or patchy understoreys.

Nesting

Only seven nest cavities have been found in British Columbia. Of these, five were in ponderosa pine (live and dead), one nest was found in Douglas-fir (*Pseudotsuga menziesii*), and one in a stump (Campbell et al. 1990). Of 43 nests found in central Oregon, 36 were in ponderosa pine (*Pinus ponderosa*) snags, 2 in ponderosa pine stumps, 2 in aspen (*Populus tremuloides*) snags, and 1 each in live quaking aspen, white-fir (*Abies concolor*) snag, and dead top of live ponderosa pine tree (Dixon 1995b).

The more decayed, large diameter snags (wildlife tree classes 5–6), often with broken tops, are preferred trees for nesting. Leaning or broken-topped snags or stumps are commonly used as nest trees, often where heart rot has created a soft interior but left the exterior hard. Raphael and White (1984) found that White-headed Woodpeckers nested in the oldest snags with advanced decay. Similarly, Milne and Hejl (1989) found only six of 176 nest sites in live trees. In south-central Oregon, 37% of the nest trees were in snags, 56% in stumps, and 6% in leaning logs (n = 16) (Dixon 1995a). The majority of nests found in central Oregon were in moderately decayed substrates (Dixon 1995a). See Table 1 for nest tree characteristics of White-headed Woodpeckers.

The nest cavities in British Columbia ranged in height from 2.4 to 9 m above ground (Cooper 1969; Cannings et al. 1987; Campbell et a1 1990). In the Sierra Nevada, Raphael and White (1984) found that White-headed Woodpecker nested at low heights (i.e., 1.9 m) compared with other cavity nesters. High-cut stumps were readily used for nesting in California (Morrison et al. 1983).

According to Thomas (1979), the White-headed Woodpecker has a requirement for high snag densities, with 558 snags/100 ha (or about 45 snags/territory) needed for maximum population densities. Most nests were found in large trees ranging in size from a mean dbh of 56 cm in west-central Idaho (Frederick and Moore 1991), to 65 cm in central Oregon (Dixon 1995a; Dixon 1995b) and 73 cm in the Sierra Nevada, California (Milne and Hejl 1989). Most of the White-headed Woodpecker nests found by Raphael and White (1984) in the Sierra Nevada were <50 cm dbh.

All seven nests found in British Columbia were found in relatively open-canopied stands (<70% canopy cover) of mature ponderosa pine forest from 450 to 600 m elevation, with most located in or on the edge of forest clearings (Campbell et al. 1990). Milne and Hejl (1989) found that the White-headed Woodpecker tended to nest in open-canopied stands with 40% of nests in stands with <42% cover and 42% in stands with 41–69% forest cover. Dixon (1995a) found forests with canopies >51% to be selected by White-headed Woodpecker in Oregon. In central Oregon, mean canopy closure was 24% at nests and 44% at roosts. The majority of nests were in partial cut old-growth (31%) and overstorey removal (44%) ponderosa pine stands; the majority of roosts were in uncut and partial-cut old-growth ponderosa pine stands (70%) (Dixon 1995a).

Roosting

Roosts were located in cavities, under sloughing bark of large ponderosa pine, and in cracks and crevices of trunks (Dixon 1995a; Garrett et al. 1996). Information on roosting requirements for this species in British Columbia is lacking.

Foraging

In British Columbia and throughout its range, White-headed Woodpecker appears to be very dependent on ponderosa pine, particularly stands with a significant mature or old-growth component (Garrett et al. 1996). In British Columbia, the White-headed Woodpecker forages in open ponderosa pine and mixed pine – Douglas-fir forests up to 1000 m elevation, very rarely moving into Engelmann spruce (*Picea engelmannii*) – lodgepole pine (*Pinus contorta*) forests up to 1300 m. White-headed Woodpecker appears most abundant where more than one species of large-seeded pine is present (Garrett et al. 1996).

Of 115 British Columbia sightings reviewed by Weber and Cannings (1976), 85% were in ponderosa pine forests, 5% in ornamental gardens (primarily at feeders), 4% in mixed ponderosa pine/Douglas-fir forests, 3% in Douglas-fir forests, 2% in Engelmann spruce/lodgepole pine forest, and 1% in a black cottonwood (*Populus balsamifera*) stand. In other areas of their range, White-headed Woodpeckers have been found at higher densities in mixed-conifer forests (Beedy 1981; Raphael and White 1984; Milne and Hejl 1989), but mature ponderosa pine forest is still extremely important (Thomas 1979). Foraging habitat in central Oregon was mainly in ponderosa pine habitat with mean canopy closure of 54%, and a mean shrub cover of 25% (Dixon 1995a). In this area, White-headed Woodpeckers spent 79% of their time foraging on live trees with a mean dbh of 74 cm.

Conservation and Management

Status

The White-headed Woodpecker is on the provincial *Red List* in British Columbia. It is designated as *Endangered* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	WA	ID	Canada	Global
S1	S3	S2B, S2N	N1	G4

Trends

Population trends

In British Columbia, White-headed Woodpecker populations have apparently fluctuated widely this century with population peaks in the 1960s and 1970s (Campbell et al. 1990). Campbell et al. (1990) reported only five records of this species between the 1890s and 1950, 15 in the 1950s, 112 in the 1960s, 68 in the 1970s and only 16 between 1980 and 1987. Very few sightings of White-headed Woodpeckers have been reported between 1987 and 2001. Recent breeding records come from the Rock Creek-Bridesville area just east of Anarchist Mountain

Table 1. Characteristics (mean) ±SD of White-headed Woodpecker nest trees from three locations

Location	Forest type	*n*	dbh (cm)	Height (m)	Nest height (m)	Citation
South-central Oregon	Ponderosa pine	16	80 ± 32	3 ± 4	3 ± 4	Dixon 1995a
Idaho	Ponderosa pine	6	56		2.8	Frederick and Moore 1991
Central Oregon	Ponderosa pine	43	65	14	4.4	Dixon 1995b

(1998 and 1999) and a few kilometres northwest of Oliver (1998) (Cannings 2000). Recent surveys by Preston (1990), Joy et al. (1995), and Ramsay (1997) failed to locate any individuals, although Gyug (1996) reported two near Naramata. The decline in woodpecker sightings is apparent despite an increasing number of naturalists and surveys looking for this species.

Based on the absence of population trends indicated from Breeding Bird Survey (Sauer et al. 1999) and Christmas Bird Count (Sauer et al. 1996) data, White-headed Woodpecker populations across their range appear to be stable over the last 30 years (Garrett et al. 1996). Populations in Oregon and Idaho have declined due to habitat loss caused by logging (Garrett et al. 1996).

Habitat trends

Of the approximately 27 500 ha of ponderosa pine–dominated forests in the south Okanagan and lower Similkameen valleys, only about 9500 ha (~ 35%) are classified as old forest, compared with the mid-1800s when the percentage old forest was likely in excess of 75% (Cannings 2000). Summaries of merchantable ponderosa pine in the British Columbia interior indicated that 3 921 450 m^3 was available in 1917, compared with only 715 761 m^3 by 1957 (Cannings 2000).

Threats

Population threats

The White-headed Woodpecker has a small population (estimated <100 pairs) in British Columbia (Cannings 2000). The long-term viability of the population is likely dependent on the breeding success of birds in Washington State and their dispersal north to British Columbia.

Habitat threats

The greatest threat to the White-headed Woodpecker in British Columbia is the ongoing loss of old ponderosa pine due to forest harvesting and urbanization (Garrett et al. 1996; Fraser et al. 1999). Old pine forests provide snags for nesting and roosting and cones for foraging. Seed production appears to be a particularly important habitat component for White-headed Woodpecker. Reductions of mature, cone-producing ponderosa pine stands could jeopardize critical winter food supplies. Ponderosa pine only produce heavy cone crops beginning at 60–100 years of age and at 4–5 year intervals in the Pacific Northwest (Oliver and Ryker 1990). As a result of logging and subsequent fire suppression, many ponderosa pine forests in the Okanagan are characterized by dense stands of young trees (Cannings et al. 1998; Turner and Krannitz 2001), presumably resulting in poor cone production. Most seeds are produced by large, dominant trees in open situations (Dahms and Barrett 1975).

Firewood cutting can also remove suitable trees for nesting and foraging (Scott and Oldemeyer 1983; Garrett et al. 1996; MELP 1998; Fraser et al. 1999).

Due to its partially insectivorous food habits, the White-headed Woodpecker is potentially affected by pesticide applications in breeding and foraging habitat (Cannings 1995; Fraser et al. 1999).

Legal Protection and Habitat Conservation

The White-headed Woodpecker, its nests, and its eggs are protected in Canada and the United States from hunting and collecting under the *Migratory Birds Convention Act*. In British Columbia, the same are protected by the provincial *Wildlife Act*.

The total area of potentially suitable habitat in the south Okanagan is 66 000 ha (MELP 1998) of which 9% is within lands managed for conservation, 42% is on provincial Crown land, 28% on Indian Reserve lands, and 21% on private land. Additional suitable habitat found east (Princeton) and west (Grand Forks and Kootenays) of the south Okanagan likely amounts to no more than 40 000 ha (Cannings 2000).

Habitat is protected within provincial parks and within lands managed and owned by the Nature Trust and the Ministry of Water, Land and Air Protection. The greatest portion of protected lands within the range of White-headed Woodpecker is in Okanagan Mountain Provincial Park (10 542 ha). Other protected areas include the Vaseux-Bighorn

National Wildlife Area and various properties owned by the Nature Trust around Vaseux Lake. A number of new protected areas that have been announced in the south Okanagan through the Okanagan-Shuswap Land and Resource Management Plan process should result in an additional 5716 ha of potential protected habitat. Some of the more important parks for White-headed Woodpeckers include White Lake Grasslands (3627 ha), South Okanagan Grasslands (9700 ha), Anarchist, Vaseux, and Adra Tunnel.

Under the results based code, the riparian and old forest retention guidelines provide some protection of habitat for this species. Old growth management areas (OGMAs) in the ponderosa pine zone, in particular, will protect important habitats for the White-headed Woodpecker. Current policy, however, directs the establishment of OGMAs to be established within the non-timber harvesting land base wherever possible. Therefore the potential overlap between OGMAs and suitable habitat for the White-headed Woodpecker is currently unknown.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Since this species prefers wildlife trees and mature and old forest, it is best managed at the landscape level through wildlife tree and old forest retention objectives.

- ❖ Maintain high suitability habitat (i.e., ponderosa pine, structural stages 6 or 7) in patches between 20 and 1000 ha. Because of this species' relatively large home range size (100–400 ha), larger patches are more suitable.
- ❖ Maximize connectivity between suitable habitats. Linkages should be composed of large areas of connecting habitats, rather than merely corridors (e.g., relatively large reserve areas containing drier, open-canopied mature and old ponderosa pine).
- ❖ Blocks should be assessed to identify potentially suitable wildlife tree retention areas. Table 2 provides recommendations for selecting wildlife tree retention areas designed to meet the needs of the White-headed Woodpecker.

Table 2. Preferred wildlife tree retention area features for the White-headed Woodpecker

Attribute	Preference
Size (ha)	≥8 ha
Location	350–750 m in elevation, PPxh
Tree features	leaning or broken-tops; heartrot
Tree species	ponderosa pine, aspen, Douglas-fir
Wildlife tree class	5 and 6
Tree size (dbh)*	≥80 cm where available; ≥45 cm for recruitment

* After Dixon 1995a.

Wildlife habitat area

Goal

Maintain historic, current and future suitable nesting habitat.

Feature

Establish WHAs at, or close to, known occurrences within suitable habitat or habitats that will provide the desired attributes in a short time period if the attributes do not currently exist.

Size

Typically between 20 to 80 ha.

Design

A WHA should include mature or old ponderosa pine forest, preferably with 40–70% canopy closure where it exists, but can range from 6 to 75% (i.e., crown closure classes 1–7) with a mix of large (≥60 cm dbh preferred, minimum 25 cm dbh) live and standing dead trees (i.e., ponderosa pine, Douglas-fir, aspen; lodgepole pine and Engelmann spruce) suitable for nesting.

General wildlife measures

Goals

1. Provide and recruit an adequate supply of suitable large diameter live and dead wildlife trees for foraging and nesting.
2. Maintain mature or old stand structure with open canopy.
3. Maintain mature cone-producing ponderosa pine to ensure non-breeding food supplies.
4. Minimize new access development (i.e., roads) to prevent habitat fragmentation and to reduce firewood cutting.

Measures

Access

- Do not construct roads. Deactivate and/or close temporary roads immediately after logging.

Harvesting and silviculture

- Do not salvage timber. When harvesting is approved follow the measures below.
- Protect and retain all ponderosa pine live and dead trees ≥50 cm dbh. Ensure recruitment of ponderosa pine >50 cm dbh.
- Maintain at least six standing dead trees/ha. Where it is not possible to retain six ≥60 cm, use the largest available. The highest practical density of snags is preferred. Hazardous snags or trees can be incorporated into group reserves (plan as no work zones if appropriate); otherwise, maintain snags within the operational setting as described in the *Wildlife/Danger Tree Assessor's Course Workbook*.
- Use partial cutting silvicultural systems to maintain 40–70% canopy cover, late seral ponderosa pine. On average, removal should be 35% but may be greater where Douglas-fir makes up a greater percentage of the stand. Group selection (openings 0.5 ha), with group reserves, or single tree selection with group reserves are the recommended silvicultural systems.
- Thin young stands to maximize growth and cone production of retained trees. When thinning, retain aspen.
- Replant with ponderosa pine.

Pesticides

- Do not use pesticides.

Additional Management Considerations

Suitable habitat could be created in currently marginal habitats using a number of forest management practices. Areas selected for enhancement should have a high density of young to mature ponderosa pine and ideally be linked to other areas of potentially suitable habitats. Potential enhancement techniques could include thinning to create an open-canopied stand leaving the largest and oldest trees, and prescribed burning to reduce densities of shade-tolerant Douglas-fir, stimulate cone production, and mimic natural cycling of the ecosystem (Joy et al. 1995).

In actively harvested areas outside of WHAs, consideration should be given to retaining all snags and a component of mature pines. Snags are an important component of the ecosystem for woodpeckers and will gradually be lost and may not be replaced under current forest management practices (Ohmann et al. 1994). Buffers around each snag would address safety concerns and provide potential habitat for woodpeckers and other wildlife. Where buffers are not possible, leaving high-cut stumps may be an option (Ohmann et al. 1994; Joy et al. 1995). Morrison et al. (1983) found that high cut stumps in Tahoe National Forest, California, were readily accepted as nest locations by White-headed Woodpecker.

Stand-replacement fires destroy potential habitats for White-headed Woodpecker. On the other hand, frequent ground fires reduce the young tree component of the forest, and will eventually lead to open stands dominated by mature and old-growth trees. Prescribed burning in potential White-headed Woodpecker habitats is an excellent habitat enhancement tool.

Additional potential nest sites in intensely managed stands may be provided by leaving some high-cut (5 m in height) stumps of large (≥60 cm dbh) ponderosa pine.

Information Needs

1. Specific habitat preferences, both botanical and structural, as well as territory size and basic population demographics of White-headed Woodpecker (Garrett et al. 1996; Fraser et al. 1999; Krannitz and Gebauer 2003).
2. The impacts of fire suppression and the effectiveness of using prescribed burning to improve habitats for White-headed Woodpecker (Turner and Krannitz 2001).

Cross References

Lewis's Woodpecker

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Williamson's Sapsucker

Sphyrapicus thyroideus

Original prepared by John M. Cooper and E.T. Manning

Species Information

Taxonomy

Two subspecies of *Sphyrapicus thyroideus* are recognized, both of which occur in British Columbia (McTaggart-Cowan 1938; AOU 1957; Cannings 1998). The "Western" subspecies, *S. thyroideus thyroideus*, breeds in central-southern British Columbia and the "Rocky Mountain" subspecies, *S. thyroideus nataliae*, breeds in extreme southeastern British Columbia.

Description

Medium-sized woodpecker. The male has a distinctly black back and breast, with white rump and wing patches; it has a bright red chin and throat and its belly is yellow. The female has a brown head with dark brown and white barring on the back, wings and sides; females lack the white wing patch and red throat, and the belly is variably yellow. Juveniles resemble adults but are duller in colour. They attain adult plumage by the first winter.

Distribution

Global

Breeds from the southern Interior of British Columbia south through the eastern Cascades and Rocky Mountains to northern Baja, northern Arizona, and northwestern New Mexico (AOU 1983; Kratter 1991; Dobbs et al. 1997). Winters from the southwestern United States south to southwestern California and north-central Mexico (Dobbs et al. 1997). In Canada, it occurs only in British Columbia and extreme southwestern Alberta.

British Columbia

The Williamson's Sapsucker is an uncommon or rare migrant and summer visitor to the southern Interior of British Columbia (Campbell et al. 1990). It has the most restricted distribution and lowest abundance of the four species of sapsuckers that occur in British Columbia (Campbell et al. 1990). Breeding occurs from the International Boundary north to at least Scottie Creek in the southern Interior (Cooper 1995) and Whiteswan Lake in the Kootenays (Campbell et al. 2000). There is a gap in the distribution between the two subspecies from the Greenwood to Cranbrook areas (Cooper 1995).

Forest region and districts

S. thyroideus nataliae

Southern Interior: Rocky Mountain

S. thyroideus thyroideus

Southern Interior: Arrow Boundary, Cascades, Kamloops, Okanagan Shuswap, Rocky Mountain

Ecoprovinces and ecosections

S. thyroideus nataliae

SIM: COC, EKT, EPM, FLV, MCR, SPK

S. thyroideus thyroideus

SIM: CCM, SCM, SFH, SPM

SOI: GUU, NIB, NOB, NOH, OKR, PAR, SHB, SOB, SOH, STU, THB

Biogeoclimatic units

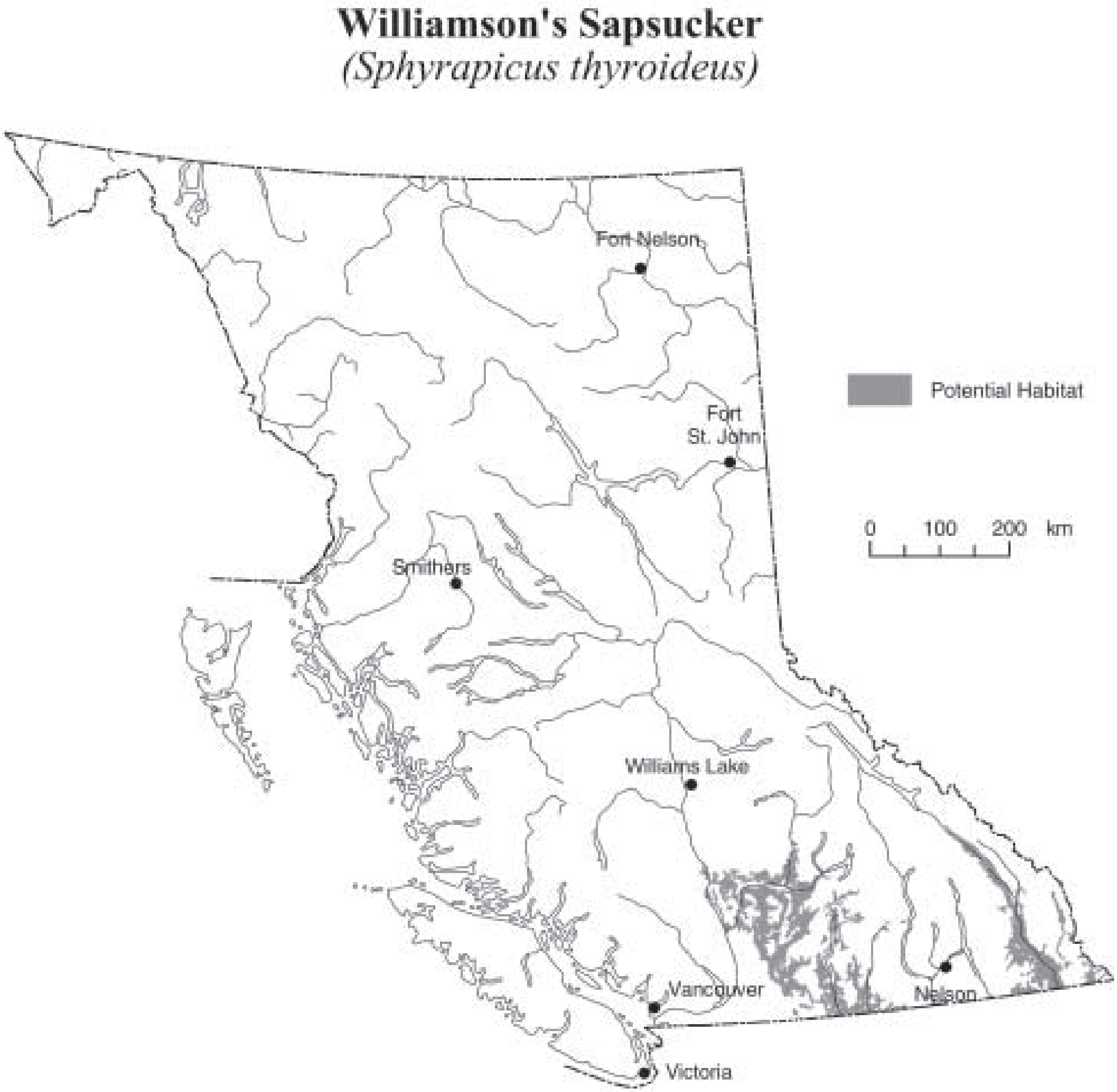
ESSF: mw (very rare)

ICH: dw, mk1, mk2, mw2, xw

IDF: dk1, dk1a, dk2, dm, dm1, dm2, mw1, mw2, un, xh1, xh1a, xh2, xh2a, xw

MS: dk, dm1, dm2, xk

PP: dh1, dh2, xh1, xh1a, xh2, xh2a



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Broad ecosystem units
CR, DF, DL, DP, IG, IS, OV, PP, SD, WR

Elevation

Williamson's Sapsuckers breed at middle to higher elevations on the Thompson-Okanagan Plateau at least as far east as Greenwood, and west to Manning Park and Lytton. It also likely breeds at similar elevations in the southern East Kootenay, from the Flathead River north to Whiteswan Lake. It has been recorded breeding at elevations of 850–1490 m (Campbell et al. 1990; Cooper 1995; Gyug 1997). A few non-breeding individuals wander beyond their normal range (Campbell et al. 1990).

Life History

Diet and foraging behaviour

Before the eggs hatch, adults feed exclusively on conifer sap and phloem. After nestlings are present, diet switches to mainly ants (Stallcup 1968; Crockett 1975). Trees used for obtaining sap are often ringed with "sap wells." These sap wells are visited several times each day, and sap trees are usually smaller than expected on the basis of availability (Dobbs et al. 1997).

Reproduction

Males establish breeding territories after arriving on breeding grounds and pairs form after females arrive, 1–2 weeks later (Crockett and Hansley 1977). Nesting habitat includes relatively open, mid-elevation coniferous forests. Cavities are excavated in trees infected with *Fomes* species or other fungal species that cause heart rot. In British Columbia, nest trees are usually conifers (Campbell et al. 1990); in other areas trembling aspen (*Populus tremuloides*) is most commonly used (Dobbs et al. 1997).

Pairs often reform between years and may reuse the same nest tree, although new cavities are usually excavated each year (Conway and Martin 1993). In one 5-year study in British Columbia, only 3 of 18 original nest trees were still being used at the end of 5 years; as pairs often moved to alternate nest trees in their areas (L. Gyug, pers. comm.).

Clutches contain four to six eggs, eggs are incubated for 12–14 days, and nestlings fledge after about 32 days (Crockett and Hansley 1977; Martin and Li 1992; Martin 1995). In British Columbia, nests with eggs or young could be found between 23 April and 15 July (Cooper 1995). Adults and young disperse from the nesting area within a few days after young fledge (Crockett and Hansley 1977). One brood is produced annually (Dobbs et al. 1997).

Site fidelity

Pairs often reform between years and may reuse the same nest tree, although new cavities are usually excavated each year (Conway and Martin 1993).

Home range

Elsewhere, home ranges have been suggested to be between 4 and 9 ha (Crockett 1975) in Colorado, and 4 and 6.8 ha in the western United States (mean home range size) (Thomas et al. 1979; Sousa 1983), but these are likely underestimated. Densities in the western United States ranged from 1 to 4.1 breeding pairs/40 ha (Stallcup 1968; Bock and Lynch 1970; Winternitz 1976).

There is very limited information for British Columbia, but home ranges are focused on the nest tree and are likely >20 ha (Manning and Cooper 1996; Gyug 1997). North of Greenwood, B.C., one Williamson's Sapsucker home range was determined by radio-telemetry data to be at least 54.2 ha (Manning and Cooper 1996). Densities of breeding pairs near Johnstone Creek (northwest of Rock Creek, B.C.), were estimated to be 1 pair/120 ha (Gyug 1997).

Movements and dispersal

The Williamson's Sapsucker is a migratory woodpecker that returns to British Columbia from late March through mid-April; fall migrants depart by mid-September (Campbell et al. 1990).

Habitat

Structural stage

Nesting: 6–7
Foraging: 4–7

Important habitats and habitat features

Nesting

Mixed western larch (*Larix occidentalis*), interior Douglas-fir (*Pseudotsuga menziesii*), and ponderosa pine (*Pinus ponderosa*) forests are important nesting habitats. In British Columbia, nests have largely been found in coniferous trees, particularly western larch, but also in ponderosa pine (especially near Princeton), Douglas-fir, lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmannii*), white spruce (*Picea glauca*), paper birch (*Betula papyrifera*), and black cottonwood (*Populus balsamifera*) (Cannings et al. 1987; Morgan et al. 1989; Campbell et al. 1990; Cooper 1995; Manning and Cooper 1996; Gyug 1997, 1999). However, in the western parts of its range in British Columbia (STU and PAR ecosections), trembling aspen appears to be the preferred nest tree species (Cooper 1995). Dobbs et al. (1997) note that Williamson's Sapsuckers usually nest in aspen where it is available.

Of the 28 nests known from British Columbia, 22 were found in conifers particularly western larch ($n = 12$) (Campbell et al. 1990). In the East Kootenay and the Southern Okanagan Highland, it is usually associated with mixed coniferous forests with stands of mature western larch. In northeastern Oregon, Williamson's Sapsucker also appear to prefer western larch; western larch comprised 62% of the live trees with nests, although dead western larch, ponderosa pine, Douglas-fir, and grand fir (*Abies grandis*) were also used (Bull et al. 1986). In Oregon, 53% of the nests occurred in the grand fir stand types and basal area was the best discriminator between used and unused habitat (Bull et al. 1986). The emphasis on grand fir is probably because these stands provide large, decaying western larch and ponderosa pine suitable for nest sites and live Douglas-fir trees for a source of sap. Williamson's Sapsucker preferred stands with <75% canopy closure, basal areas <34 m^2/ha, two or three canopy layers, and >1 dead tree/ 0.1 ha (Bull et al. 1986).

In British Columbia, north of Greenwood, nest trees were on south-facing slopes; none were found on north-facing slopes (Manning and Cooper 1996). However, nest trees near Rock Creek and Midway occurred on any and all aspects if slopes were <30%; but if slopes were >41%, all nest trees were on north- or west-facing slopes (Gyug 1997, 1999).

Williamson's Sapsuckers usually excavate a new nest cavity every year, although nest trees may be used in successive years (Cooper 1995; Dobbs et al. 1993). The Williamson's Sapsucker needs live or recently dead trees containing heart rot decay for cavity excavation (wildlife tree classes 2–5). Similar to the research findings in Oregon, all nest trees found at Wallace Creek, B.C., were in live larch with evidence of decayed wood in the upper bole (tree decay class 2 with dead or broken soft tops) (Manning and Cooper 1996). In Oregon, of 86 nest trees, 51% were found in "hard snags" (dead <3 yr.) and 49% in live trees (Bull et al. 1986). Also, 73% of Williamson's Sapsucker nest trees had 75% of the original bark, and a mean of 61% of the branches were remaining and 64% of the nest trees had broken tops (Bull et al. 1986).

They generally require larger trees (i.e., >30 cm dbh but coniferous nest trees are usually >50 cm dbh) (Table 1). In three recent studies conducted in the Arrow Boundary forest district (Northern Okanagan Highland and Selkirk Foothills ecosections) the Williamson's Sapsuckers clearly selected larger diameter (>60 cm dbh) western larch as nest trees (Gyug and Bennett 1995, Manning and Cooper 1996, Gyug 1999). Gyug (1997) found Williamson's Sapsucker nests in large live western larch 70–110 cm dbh. No nest trees have been recorded as single trees standing alone in an opening, but are usually found within an open stand or within a patch of larger trees (Manning and Cooper 1996).

It is likely that the condition (i.e., heartwood decay), structural characteristics (i.e., tree diameter and height), and abundance of suitable nest trees are limiting factors influencing Williamson's Sapsucker distribution and abundance in some areas of their range. Cannings et al. (1987) suggested that the distribution of western larch may be a limiting habitat factor for this species in the Okanagan. Stands of +200- year-old western larch are the best nesting habitat available in British Columbia, but not all such stands have the veteran larch needed as

Table 1. Characteristics (mean ± SD) of Williamson's Sapsucker nest trees from three locations

Forests	Location	*n*	Tree dbh (cm)	Tree height (m)	Nest height (m)	Citation
Western larch, ponderosa pine	Oregon	86	70 ± 26.4	24 ± 10.1		Bull et al. 1986
Ponderosa pine, Douglas-fir	Colorado	40	23.5			Crockett and Hadow 1975
Aspen, western larch	British Columbia	25			2–18	Campbell et al. 1990

nest trees (Gyug 2000). Veteran larch needed for nest trees are usually much older than the "stands" they occur in, and have survived one or two stand-maintaining fires.

Foraging

Live trees, in open to semi-open (<75% canopy cover) mixed coniferous forests that include western larch, Douglas-fir, grand fir, and trembling aspen are important foraging habitat (Crockett and Hadow 1975; Bull et al. 1986; Dobbs et al. 1997). North of Greenwood, Williamson's Sapsuckers preferentially fed in pole/sapling stage (20–40 years age) Douglas-fir and western larch stands (Manning and Cooper 1996). The mean dbh of trees used for sap wells in these stands was 27.6 cm (Douglas-fir) and 44.2 cm (western larch).

Roosting

This sapsucker roosts in natural or excavated cavities in trees (Dobbs et al. 1997), probably similar in size and species composition to those used for nesting.

Conservation and Management

Status

The "Rocky Mountain" Williamson's Sapsucker (subspecies *nataliae*) is on the provincial *Red List* in British Columbia. The "Western" Williamson's Sapsucker (subspecies *thyroideus*) is on the provincial *Blue List*. Their status in Canada has not been determined (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

There are few breeding records for the *nataliae* subspecies during the last 5 decades and, presumably, there is a very small population (Cooper 1995; Cannings 1996; Fraser et al. 1999). The *thyroideus* subspecies also has a small population. Population trends are unknown, but Fraser et al. (1999) suggest that the *nataliae* subspecies may be declining whereas the *thyroideus* subspecies is likely stable or slowly declining.

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

Subspecies	BC	CA	ID	MT	OR	WA	Canada	Global
Rocky Mountain	S1S2B		S5B, SZN	S4B, SZN			N2?B, N?N	G5TU
Western	S3B, SZN	S3			S4B, S3N	S4B, SZN	N3B, N?N	G5TU

Habitat trends

High suitability habitat for Williamson's Sapsucker is likely declining in British Columbia because of the harvesting of stands of old and mature western larch, ponderosa pine, and Douglas-fir.

Threats

Population threats

A small population restricted to the southern Interior of British Columbia makes this species vulnerable to extirpation.

Habitat threats

The primary threat to this species' habitat throughout most of its range in British Columbia is logging of mature or old western larch and Douglas-fir stands. Locally, near Princeton and perhaps in other areas, logging of old-growth ponderosa pine threatens small populations. In British Columbia, this sapsucker nests mainly in large decadent western larch, and occasionally in other tree species including Douglas-fir, trembling aspen, and ponderosa pine. Clearcuts usually remove habitat while selection logging often removes large trees that are needed for recruitment as future nest trees (Cooper 1995; Fraser et al. 1999). Cutting of decadent western larch identified as danger trees near work areas may remove high quality nest trees.

Legal Protection and Habitat Conservation

The Williamson's Sapsucker, its nests, and its eggs are protected from direct persecution in Canada and the United States by the *Migratory Birds Convention Act*. In British Columbia, the same are protected under the provincial *Wildlife Act*.

Only a few nesting areas are currently within protected areas (e.g., Manning Park, Okanagan Mountain Park, and Yellow Pine Ecological Reserve) (Cooper 1995; Fraser et al. 1999).

Virtually all habitat is Crown land; thus habitat conservation may be partially addressed by the old forest retention, wildlife tree retention area, and riparian reserve recommendations in the results based code. Patches of mature or old forest habitat that include potential nest trees should maintain breeding pairs because of relatively small home ranges and the fact that foraging can be accommodated in younger (20–40+ years) stands.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

The objective for this species is to maintain wildlife trees >60 cm dbh for coniferous species and >30 cm dbh for deciduous species for nesting across the breeding range and over time. Consider wildlife tree retention area and old growth management area objectives for the Williamson's Sapsucker in the following forest districts: Rocky Mountain, Kamloops, Okanagan Shuswap, Cascades, and Arrow Boundary.

Blocks should be assessed to identify potentially suitable WTR areas. Table 2 provides recommendations for WTR areas and OGMAs.

It is recommended that salvage not occur in WTR areas and OGMAs established to provide habitat for this species. In addition, these areas should be designed to include as many suitable wildlife trees as possible that should be maintained over the long term (>80 years).

In addition, the following general practices could provide for suitable habitat for Williamson's Sapsuckers.

- ❖ Use partial cutting silvicultural systems to maintain habitat attributes suitable for Williamson's Sapsuckers in areas scheduled for harvesting. These can include silvicultural systems that employ some type of patch retention (e.g., WTR areas and RMAs), or other partial cutting system that retains scattered trees with suitable habitat attributes.
- ❖ In areas scheduled for harvesting, regardless of the silvicultural system chosen, retain ALL VETERAN western larch and ponderosa pine as wildlife trees. Also retain some mature western larch, ponderosa pine, or Douglas-fir >60 cm dbh, especially if these trees have broken or dead tops, evidence of heart rot decay (fungal conks,

Table 2. Preferred WTP considerations for Williamson's Sapsuckers

Attribute	Characteristics
Size (ha)	at least 0.25 ha; preferably larger
Location	see "Biogeoclimatic units" above
Tree features	signs of woodpecker use (i.e., cavities); structural defects such as dead or broken tops, or presence of fungal conks and other evidence of internal tree decay
Tree species	veteran larch preferred when available, but also ponderosa pine, Douglas-fir, and grand fir; trembling aspen in the western part of the range
Tree size (dbh)	70–96 cm or larger (after Bull et al. 1986); in the absence of trees with the preferred dbh, deciduous trees ≥30 cm dbh and ≥50 cm dbh for coniferous species should be retained for recruitment
Wildlife tree class	class 2–6, especially with soft dead or broken tops, or fungal conks

large stem scars), or evidence of wildlife use (e.g., nest cavities). In the western parts of the sapsuckers' range, retain some live aspen >30 cm dbh with broken tops, stem scars, canker faces, fungal conks, or nest cavities. Retain in patches.

- ❖ Leave advance regeneration, pole-saplings, and deciduous vegetation around wildlife trees to enhance their habitat quality.
- ❖ Employ silvicultural stand tending practices to promote semi-open stands (<75% canopy crown closure) containing trees with suitable habitat attributes for Williamson's Sapsucker. Variable density planting and spacing treatments, and prescribed understorey burning can produce open stands of this description.
- ❖ Increase retention of mature and old stands with mixed western larch, Douglas-fir, and lodgepole pine on south-facing slopes in the ICH, MS, and on north-facing slopes in the IDFxh1 and IDFdm1. Increase retention of large diameter ponderosa pine in the IDFdk.
- ❖ Due to the importance of mature and old western larch for breeding and foraging habitat for Williamson's Sapsucker, areas known to contain large, decadent western larch should be included in landscape level planning strategies that can incorporate areas with suitable habitat attributes for this species (e.g., OGMAs, ungulate winter range).

Wildlife habitat area

Goal

Maintain known Williamson's Sapsucker breeding sites.

Feature

Establish WHAs at known nest sites, especially where high suitability habitat containing large diameter western larch and ponderosa pine exist.

Size

Typically between 20 and 50 ha around known nest trees, depending on the extent of remaining high suitability habitat occurring within the estimated home range (i.e., smaller WHAs are acceptable when habitat features are abundant within the home range area.

Design

The WHA should include, where present, mature or old western larch stands. Important features to include are veteran larch with dead or broken tops and/or evidence of heart rot decay (e.g., fungal conks, canker faces, large stem scars, existing nest cavities). In the western parts of its range, large diameter live trembling aspen with evidence of heart rot decay is also used for nesting.

Williamson's Sapsucker also prefers large (>60 cm dbh) dead trees with advanced stages of wood decay for cavity excavation. Include as many wildlife trees as operationally possible within the WHA to provide a range of present and future nest and roost trees.

General wildlife measure

Goals

1. Maintain suitable nesting trees.
2. Ensure WHA is windfirm.

Measures

Access

- Do not construct roads unless there is no other practicable option.

Harvesting and silviculture

- Do not salvage or harvest.

Pesticides

- Do not use pesticides.

Additional Management Considerations

Recruitment of future nest trees can be enhanced by retaining large-diameter western larch, ponderosa pine, and Douglas-fir green leave trees (i.e., class 1 or class 2 seed trees) in harvest openings. These trees should be reserved in patches for at least one rotation length or longer to reach suitable diameter and condition (i.e., with dead or broken tops) for use by sapsuckers. Retention of advance regeneration, saplings, and deciduous vegetation around green leave trees will enhance their habitat quality.

In areas with high suitability/capability for Williamson's Sapsucker habitat (these will be areas with old and mature western larch and Douglas-fir), and especially around nest trees and potential nest trees, silvicultural systems such as variable retention, which mimic the effects of stand-maintaining fire events, or the use of prescribed fire (i.e., understorey burning), should be used to maintain large diameter larch and Douglas-fir across harvest rotations. This is particularly important where large structurally defective class 2 trees and large dead trees, are found. Old larch and Douglas-fir are seral species that often remain after stand-thinning or stand-destroying fires (Meidinger and Pojar 1991).

Western larch should also be planted as future recruitment nest trees on sites where this is silviculturally appropriate.

Information Needs

1. Breeding territory and home range size.
2. Effectiveness of partial cutting silvicultural systems for provision of habitat attributes suitable for Williamson's Sapsucker.

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Mammals

Fringed Myotis

Myotis thysanodes

Original[1] prepared by Mike Sarell

Species Information

Taxonomy

The *Myotis* are the most widespread and diverse genus of vespertilionids in the world. They represent nine of the 16 bat species documented for British Columbia. Three subspecies of Fringed Bats are recognized. British Columbia's population (*M. thysanodes thysanodes*) belongs to the subspecies with the largest distribution (van Zyll de Jong 1985). There is a possibility that the Oregon coast subspecies (*M. thysanodes vespertinus*) may extend into southwestern British Columbia (Nagorsen and Brigham 1993) but there are no records to confirm.

Description

The Fringed Myotis is larger than most others in its genus in British Columbia, except for the Long-legged (*M. volans*) and Western Long-eared (*M. evotis*). They have a wingspan of about 28 cm and a forearm length of 42 mm (Nagorsen and Brigham 1993). The colouring of the dorsal fir is a tan brown, making it lighter coloured than many other Myotis species in British Columbia. The fringe of hairs on the outer edge of the tail membrane can be seen with the unaided eye and is a distinguishing feature of this species.

Distribution

Global

The Fringed Myotis occurs widely across western North America from southern British Columbia to Veracruz and Chiapas in Mexico (Nagorsen and Brigham 1993), with isolated populations in the Black Hills and southeastern Wyoming, South Dakota, and western Nebraska (O'Farrell and Studier 1980) and coastal Oregon (Orr 1956).

British Columbia

In British Columbia, the Fringed Myotis appears to be restricted to the dry interior. Most records are from intensive surveys in the south Okanagan (Collard 1991; Holroyd et al. 1994; Sarell and Haney 2000), but recent captures have extended their range to the Squilax area of the Shuswap (Milligan 1993), other parts of the Thompson (Firman 1994; Firman et al. 1995), the Kettle Valley (Sarell et al. 1997), and into the Cariboo up the Chilcotin River (Roberts and Roberts 1992) at Alkali Lake (Roberts and Roberts 1992; Holroyd et al. 1994). This bat may occur in other suitable areas in the dry interior of the province (e.g., Nicola, Lillooet, West Kootenays), but these areas have been less intensively inventoried.

Forest region and districts

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin, Kamloops, Okanagan Shuswap

Ecoprovinces and ecosections

CEI: CAB(?), CHP(?[2]), FRB

SIM: SFH(?)

SOI: GUU, NIB, NOB, NOH, OKR, PAR(?), SHB, SOB, SOH, STU, THB

Biogeoclimatic units

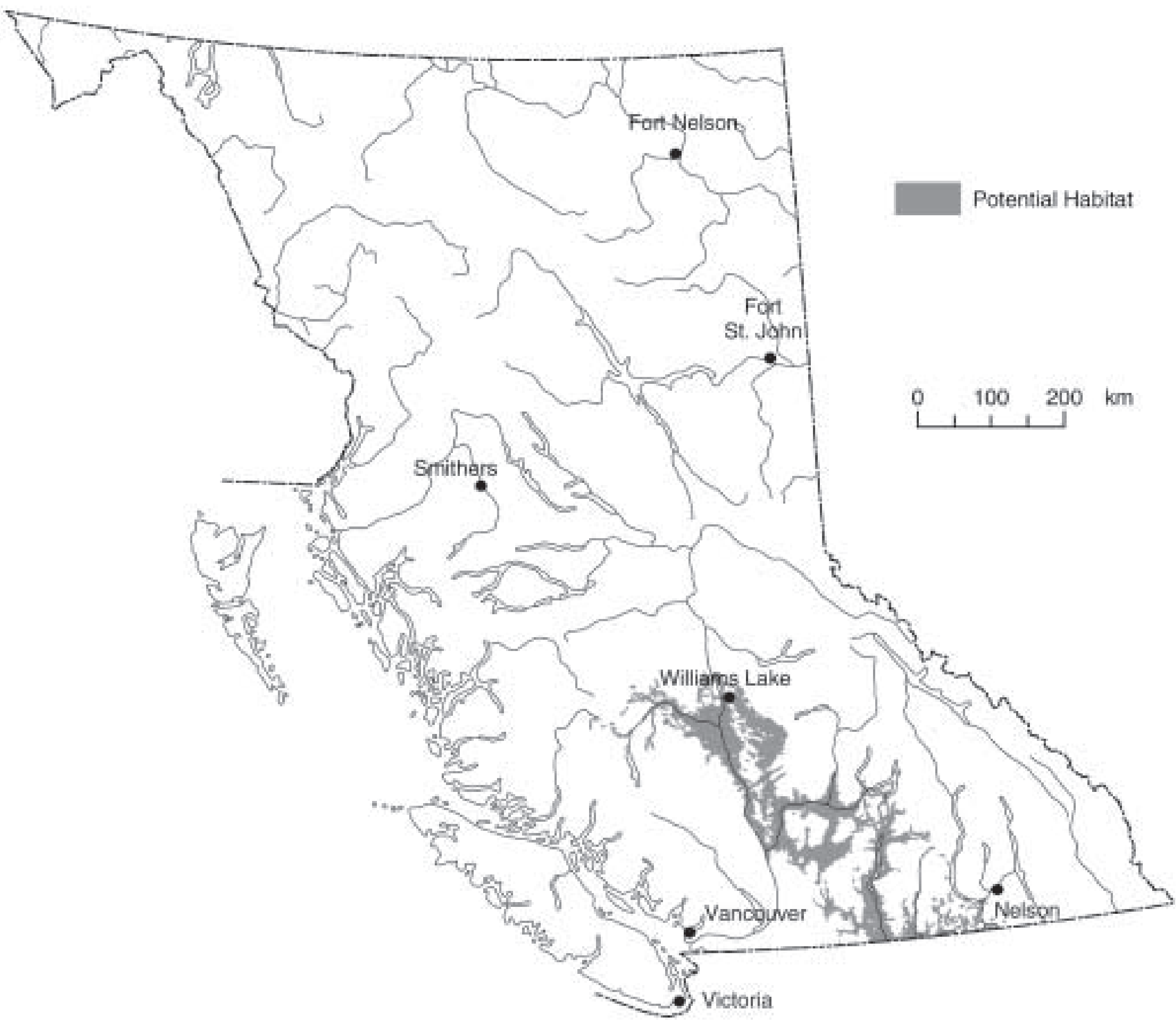
BG: xh1, xh2, xh3, xw, xw1, xw2

ICH(?): dw(?), mw2(?), xw(?)

1 Draft account for Volume 1 prepared by S. Rasheed.

2 (?) Indicates that the range extent has not been determined.

Fringed Myotis
(Myotis thysanodes)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

IDF: dk1(?), dk2(?), dk3(?), dk4(?), dm1(?), mw2(?), xh1, xh1a, xh1b, xh2, xh2a, xh2b, xm, xw

PP: dh1, dh2, xh1, xh2

Broad ecosystem units

Roosting: CL, DP(?), RO, PP(?)

Foraging: AB, AC, BS, CF, CR, DF, DP, LS, ME, OV, PP, RO, SP, SS, WL

Elevation

Fringed Myotis are usually captured between 300 and 854 m in British Columbia (Nagorsen and Brigham 1993). The capture reported for an elevation of 1400 m near Squilax (Milligan 1993) was actually ~380 m.

Life History

Diet and foraging behaviour

Little is known of the foraging behaviour of these bats. They are often caught near watercourses and tend to fly close to the canopy (Rasheed et al. 1995), as well as in open grassland habitats. Maternity colonies have been discovered in rural/agricultural settings in British Columbia, and although foraging behaviours were not determined, extensive orchards surrounding the roosts may have been used as foraging habitat. The possibility of varied forging habitat preferences is reflected in their diverse diet of beetles (Black 1974), moths, leafhoppers, harvestmen, and crickets (Whitaker et al. 1977), and lacewings and flies (Nagorsen and Brigham 1993). Many of these insects are fully terrestrial, suggesting that gleaning is employed as a predatory technique. One hypothesis is that the “fringe” is used to strip insects from vegetation. The likelihood that they glean their prey is also supported by their slow and manoeuvrable flight and their wings have high puncture strength, typical of other gleaning bat species that could otherwise tear wings against branches and thorns (O’Farrell and Studier 1980).

Reproduction

Copulation is thought to occur in the fall, and fertilization delayed until spring (O’Farrell and Studier 1980). Adult females form maternity colonies, numbering up to 300 in parts of their range (Rasheed et al. 1995), although both colonies observed in British Columbia were <40 (Maslin 1938; Sarell, unpubl. obs.). These two colonies were in attics of occupied houses although two other maternity colonies are suspected to occur in small cliffs (Sarell and Haney 2000). Typically, a single young is born each year, presumably in early July (Nagorsen and Brigham 1993). The low birth rate is offset by the longevity of this bat, recorded to live up to 18 years (Tuttle and Stevenson 1982).

Site fidelity

Site fidelity to roosts has been demonstrated to be high. A Fringed Myotis was captured at the same mine near Oliver 8 years after being banded (Nagorsen and Brigham 1993). Two maternity roosts in buildings have been identified in the province, and they all showed long periods of occupations (Maslin 1938; Sarell, unpubl. obs.).

Home range

There is no information on the home range of the Fringed Myotis throughout its range.

Movements and dispersal

Anecdotal evidence suggests that in the southern portion of this species’ range, they travel short distances from summer to wintering ranges (Studier and O’Farrell 1972). Spring return to maternity colonies is rapid and synchronous. As well, parturition occurs within a narrow timespan, suggesting that the individuals are behaving synchronously for much of the year (O’Farrell and Studier 1976). There have been no observations made of seasonal movements or dispersal in British Columbia.

Habitat

Structural stage

Structural stage may be an important factor in foraging habitats but there have been no studies to document this. Foraging and roosting habitats often are found in interior dry forests (Nagorsen and Brigham 1993).

Important habitats and habitat features

Roosting

Caves, rock crevices, mine tunnels, and buildings have been well documented as providing day, night, and maternity roosts. Because this species roosts in colonies, suitable roosts may need to accommodate a number of individuals. It was recently discovered that Fringed Myotis in Arizona also form maternity roosts under loose bark in ponderosa pine (*Pinus ponderosa*) snags (Rabe et al. 1998). The wildlife tree classification would be described as class 4. Roosting in trees has not yet been documented in British Columbia. Maternity roosts typically have warm aspects, presumably to facilitate the thermoregulatory needs of pups and females.

The winter ecology of this species is poorly known throughout its range, although late summer fat accumulation in places other than British Columbia suggests that these bats hibernate (Ewing et al. 1970; O'Farrell and Studier 1980). The only observations of hibernation have been in caves, consisting of a few individuals in the Black Hills of South Dakota and of solitary individuals in Oregon (Martin and Hawkes 1972; Rasheed et al. 1995). There are no winter records for this species in British Columbia (Nagorsen et al. 1993).

Foraging

The Fringed Myotis occurs in a variety of habitats including mid-elevation grasslands, deserts, and woodlands. In British Columbia, this species is most closely associated with arid grassland and Ponderosa Pine–Douglas-fir (*Pseudotsuga menziesii*) forest (Rasheed et al. 1995). Fringed Myotis are reputed to have strong preferences for foraging over watercourses and close to the vegetative canopy, primarily in ponderosa pine and Douglas-fir forests (Rasheed et al. 1995). However, Fringed Myotis also are captured in grassland habitats (Williams 1968; O'Farrell and Studier 1980; Sarell and Haney 2000). These observations were always within an hour's flight of forested habitat (O'Farrell and Studier 1980). This apparent preference may be an artefact of surveyor preference for trapping where bats are most abundant (e.g., wetlands) and due to low capture rates in open landscapes. Foraging also may occur in orchards where roosts are provided (Maslin 1938; Sarell, unpubl. obs.) but this needs direct testing. There is some evidence of higher activity in old growth and mature stands (age class 5–9; stage 6–7) in Oregon (Thomas and West 1991).

Conservation and Management

Status

The Fringed Myotis is on the provincial *Blue List* in British Columbia (CDC 2002). In Canada, it is designated as a species of *Special Concern* (COSEWIC 2002).

Summary of status in British Columbia and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	WA	Canada	Global
S2S3	S1?	S3	S3?	N2N3	G4G5

Trends

Population trends

There have been few studies on population trends of Fringed Myotis throughout their range. In the 1960s, populations in the United States appeared to be quite stable (O'Farrell and Studier 1980). Populations are probably most vulnerable at maternity colonies and at hibernacula. Population trends have not been studied in British Columbia.

Habitat trends

Loss of habitat has been rapid and extensive throughout much of the Fringed Myotis' range in British Columbia. The habitats most prone to development are in the Okanagan and the least prone are in the Cariboo. The impacts of veteran tree and snag removal from forests may have a significant impact throughout their range in British Columbia, but this cannot be determined for certain until it is known how dependent Fringed Myotis are on tree roosts.

Threats

Population threats

Maternity colonies may be prone to disturbance, although abandonment has not been documented (O'Farrell and Studier 1980). Furthermore, maternity colonies could be readily disrupted if the roost structure is destroyed. Colonies in rock crevice roosts are susceptible to destruction through road construction and other activities requiring blasting. It is not known whether recreation activities, such as rock climbing or spelunking, may disrupt colonies, causing mortality, especially to young. No studies have examined the effects of pesticides on population performance.

Habitat threats

Urbanization, road construction, and possibly logging of old growth and/or the removal of snags may be some of the greatest threats to Fringed Myotis habitat. The eradication or exclusion of bats from attics also may be significantly impacting habitat availability. Roosts in caves, mines, and fractures are susceptible to modifications to accommodate recreation and to destruction from road construction and quarrying. Livestock excrement may contaminate surface water to the extent that it becomes unusable or unhealthy.

Legal Protection and Habitat Conservation

The Fringed Myotis is protected, in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act.*

There are no known roosts within conservation holdings, although two are suspected to be on lands controlled by the Canadian Wildlife Service and The Nature Trust of BC.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- ❖ Provide adequate representation of foraging and roosting habitat in the landscape by either establishing WHAs when necessary or applying forest practices to ensure habitat representation.
- ❖ Maintain a variety of seral stages to ensure long-term provisions of foraging and roost requirements.

Wildlife habitat area

Goal

Maintain roosting, hibernating, or breeding sites.

Feature

Establish WHAs at known hibernacula and maternity roosts. Locating these features may be difficult without conducting radio-telemetry so areas with multiple individuals near suitable roosting features can also be designated as WHAs. These roosts may occur in rock outcrops and wildlife trees.

Size

Generally 12 ha but will depend on site-specific factors, including the proximity of alternate roosts. Further observations may determine whether this area is adequate.

Design

The WHA should include a 100 m radius core area and a 100 m radius management zone. When drafting boundaries consider bat movements between roosts during the breeding season, and the fact that bats may require several maternity trees per year for suitable roosting habitat. A similar design will be required for hibernacula, except the feature will be isolated and likely will not require connectivity.

General wildlife measures

Goals

1. Maintain all known roosting sites, including wildlife tree recruits for future roosting.
2. Maintain foraging habitat and prey abundance.
3. Minimize disturbance during critical times.
4. Minimize access.
5. Maintain riparian areas in a properly functioning condition.
6. Maintain hibernacula (if discovered).

Measures

Access

- Do not develop roads.
- Do not disturb rocky outcrops, loose boulders, or talus.

Harvesting and silviculture

- Retain some large trees (30–50 cm dbh) and all large (>50 cm dbh) ponderosa pine.
- Retain all large diameter (>30 cm dbh) wildlife trees (class 3–8).
- Prescribe logging in the lower diameter classes at a level that ensures future recruitment of large diameter stems and mimics a fire maintained stand (NTD4).
- Do not harvest or salvage between 1 May and 31 August if WHA includes a maternity colony.

Pesticides

- Do not use pesticides.

Range

- Plan grazing to meet GWM goals.

Recreation

- Do not establish recreation sites or trails, especially where trails would require the felling of wildlife trees.

Additional Management Considerations

Install bat-friendly gates to the entrance of caves and mines that have bat use. Install and maintain bat houses as part of the rehabilitation program. Bat Conservation International provides information regarding installation procedures of both gates and bat houses (www.batcon.org).

Information Needs

1. Specific roost requirements, especially tree roosts, in different biogeoclimatic zones, as well as effects of different silvicultural systems on roost and foraging habitat availability.
2. Seasonal roosting behaviours of maternity colonies, especially the strategies and spatial distribution of these roosts.
3. Hibernation sites need to be determined, as well as the distance travelled between hibernation sites and summer roosts.

Cross References

Bighorn Sheep, Spotted Bat, White-headed Woodpecker

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Spotted Bat

Euderma maculatum

Original[1] prepared by Mike Sarell

Species Information

Taxonomy

The genus *Euderma* is monotypic and restricted to western North America (van Zyll de Jong 1985). There are no subspecies recognized.

Description

The Spotted Bat is a relatively large bat (wingspan of 35 cm, weight 18 g) and is very distinct from other bat species. It has enormous, pink ears and three white spots on its black back, one on each shoulder and one on the rump (van Zyll de Jong 1985). For a detailed description, see Nagorsen and Brigham (1993).

Distribution

Global

The Spotted Bat occurs in Mexico, California, Arizona, New Mexico, Colorado, Utah, Idaho, Montana, Oregon, Nevada, Texas, Washington, and British Columbia (Nagorsen and Brigham 1993; Sarell and McGuinness 1993). It has a somewhat discontinuous distribution across western North America which can be attributed to a lack of observations.

British Columbia

This species is restricted to dry interior valleys in British Columbia, which represent the northern extent of its global range. It occurs from the southern Okanagan Valley north to Williams Lake (Nagorsen and Brigham 1993; Holroyd et al. 1994) and west to Lillooet (Nagorsen and Brigham 1993). Spotted Bats appear to be absent east of the Okanagan Valley, despite similar climate and apparently suitable habitat (Sarell et al. 1998).

Forest regions and districts

Southern Interior: 100 Mile House, Cascades, Central Cariboo, Chilcotin, Kamloops, Okanagan Shuswap

Ecoprovinces and ecosections

CEI: CAB, CHP, FRB

SOI: NOB, NOH(?), OKR, PAR, SCR, SOB, STU, THB

Biogeoclimatic units

BG: xh1, xh2, xh3, xw2, xw3

IDF: dk(?), dm(?), mw(?), xh1a, xh1b, xh2a, xh2b, xw

PP: xh1, xh1a, xh2, xh2a

Broad ecosystem units

Roosting: BS, CL, RO, SS (DF, DP, PP – steep south facing slopes only)

Foraging: AB, BS, CF, CR, DF, DP, LL, LS, OV, PP, RO, SP, SS

Elevation

In British Columbia, Spotted Bats are found at elevations between 300 to 900 m, although most occurrences are below 500 m (Nagorsen and Brigham 1993). In other parts of its range, it has been found from sea level to 3300 m (Garcia et al. 1995).

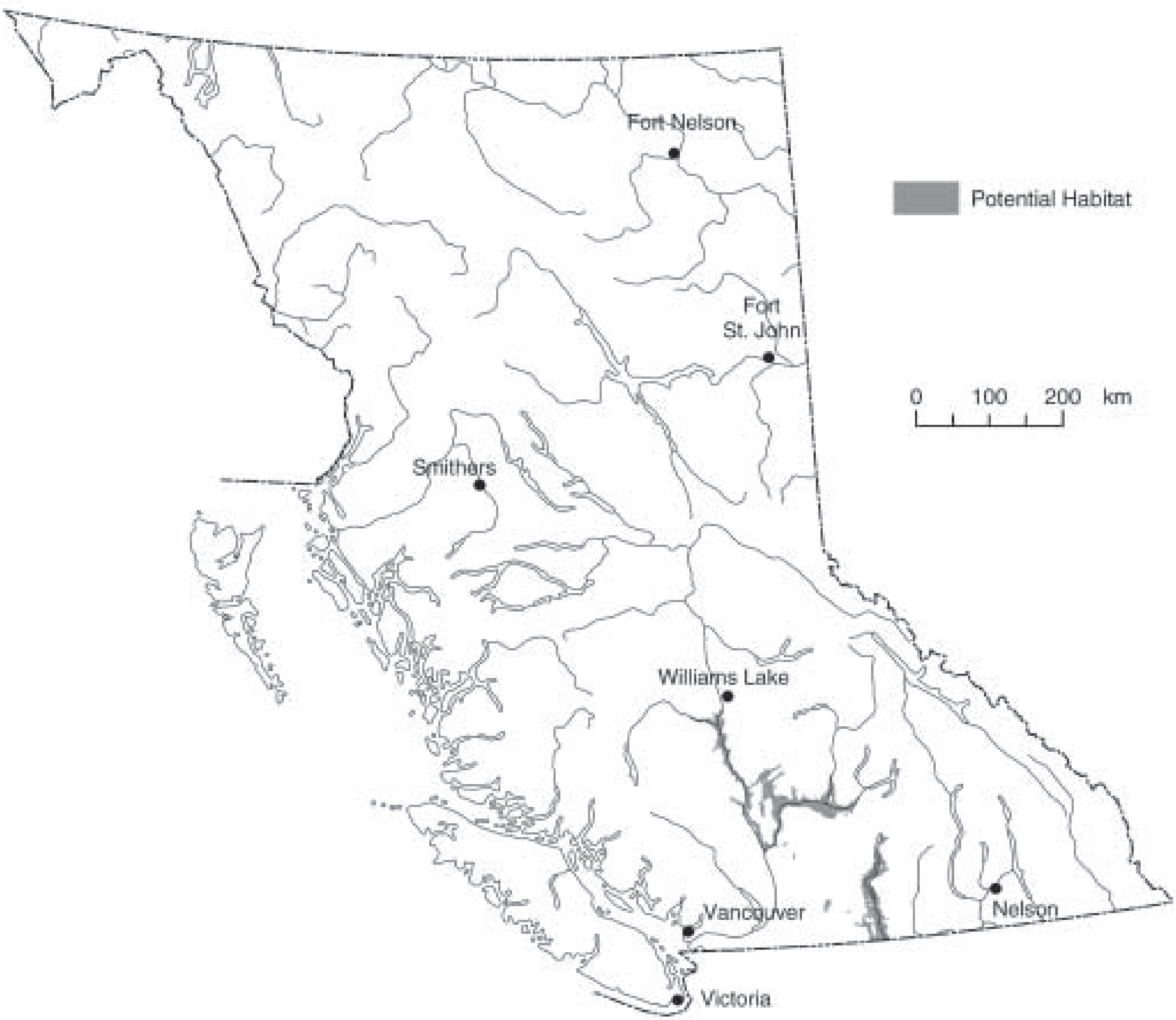
Life History

Diet and foraging behaviour

The Spotted Bat is an aerial insectivore and feeds almost exclusively on moths. Individuals maintain exclusive foraging areas when more than one individual is present in an area. Foraging takes place at heights of 5–15 m or higher, mostly over open ponderosa pine stands, fields, marshes, and riparian

1 Draft account for Volume 1 prepared by S. Rasheed.

Spotted Bat
(Euderma maculatum)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

habitat. Night roosts are seldom used. These bats usually forage continuously on the wing except for briefly landing on cliffs or large, solitary pine trees.

Reproduction

Spotted Bats are believed to be solitary breeders (Balcombe 1988). It is suspected that Spotted Bats mate in the fall, like most other temperate bat species, and then delay fertilization until the following spring (Easterla 1973). A single young is born in late June or early July (Nagorsen and Brigham 1993) and become volant in late July (Sarell and Haney 2000). The low fecundity rate is offset by the probable longevity of the species, as most North American bats live for 10–30 years.

This bat is solitary and never encountered in colonies, although there is usually more than one bat inhabiting a cliff face but in separate roosts.

Site fidelity

Spotted Bats exhibit strong fidelity to roost cliffs and foraging circuits for much of the active season (Wai-Ping and Fenton 1989), although several roosts may be used during the active season (Sarell and Haney 2000). Hibernacula are unknown but Spotted Bats probably exhibit an even stronger fidelity to these sites as thermal and security requirements are paramount and unlikely to be widely available.

Home range

There are limited data on home ranges (Wai-Ping and Fenton 1989). Adults forage up to 10 km away from day roosts, suggesting home ranges of about 10 km^2. Home ranges overlap but conspecifics are avoided while foraging. Roosting is solitary yet cliffs may host many individuals, probably depending on the number of discreet roost features.

Movements and dispersal

Distances of up to 10 km (one way) between roost and feeding areas may be covered in a night. In the early summer, Spotted Bats exhibit both temporal and spatial predictability in their daily activity, using the same commuting routes, and feeding areas; they also return to the same 'day' roosts night after night. In the late summer, activity becomes less predictable and foraging and roosting habitat shifts may occur. Movements between roost sites are thought to be within their home ranges (Wai-Ping and Fenton 1989; Sarell and Haney 2000).

Habitat

Structural stage

There are no structural stage preferences known for this species, as they roost in large cliffs and often forage well above the canopy. Any influences on foraging from structural stage may be subtle and related to the production and availability of preferred prey.

Important habitats and habitat features

Roosting

The Spotted Bat is closely associated with rugged arid habitats. The availability of suitable cliffs and crevices may be limiting and may explain the discontinuous distribution of Spotted Bats. Steep, high cliffs within a few kilometres of suitable feeding areas (riparian areas, marshes, fields, grasslands, and open forest) and close to a source of water are important as day roosts (Collard 1991) and possibly as hibernation sites. Crevices within such cliffs must offer protection and a suitable thermal regime.

Day roosts are typically located in crevices in steep, tall cliffs. Individuals roost singly, although many individuals may roost in the same cliff (Sarell and Haney 2000). Several roosts may be used in a season, probably a result of seasonal weather changes or for reproductive requirements (Wai-Ping and Fenton 1989; Sarell and Haney 2000).

Foraging

Grassland, parkland, forest, wetland, and riparian areas provide abundant prey (Leonard and Fenton 1983; Wai-Ping and Fenton 1989). None of these habitats is known to be of greater value than the others (Navo et al. 1992). Foraging corridors, such as lake edges, may be used (Wai-Ping and Fenton 1989; Sarell and McGuinness 1993). These edges may act as navigation cues.

Wintering

No information is known about the winter habits of the Spotted Bat in BC and scant information is available for this species elsewhere in its range (Nagorsen et al. 1993). Early spring and late fall observations suggest that the species does hibernate near its summer range (Bryant 1989; Roberts and Roberts 1992; Sarell and Haney 2000). In more southerly parts of its range, Spotted Bats are thought to hibernate in the same location crevices as their summer roosts (Ruffner et al. 1979; Poche 1981). There is one unsubstantiated record (1930) of four individuals hibernating in a cave in Utah (Hardy 1941).

Conservation and Management

Status

The Spotted Bat is on the provincial *Blue List* in British Columbia. It is designated as a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	WA	Canada	Global
S3	S2	S3	N3	G4

Trends

Population trends

Spotted Bats were not detected in British Columbia until 1976. The population is estimated to be at least 200 individuals but many areas have not yet been surveyed; however, the population is considered small (Cannings et al. 1999). A recent study in the south Okanagan (Sarell and Haney 2000) suggests that there have been no significant changes in the population of Spotted Bats over the last two decades. There have not been similar studies conducted elsewhere in the province. Several Spotted Bats have been found dead or dying throughout the province (Okanagan Falls, Vaseux Lake, Salmon Arm, and Lower Nicola) although no association has been inferred between these mortalities.

Habitat trends

Roosting habitat is fairly secure from physical disturbances as cliffs are rarely altered, other than the natural sloughing of colluvium. Exceptions in British Columbia have occurred where rock-climbing routes have been established (Sarell et al. 1996) and where talus extraction occurs. Some roosts are now protected by the establishment of conservation holdings, particularly in the core of their range in the south Okanagan (Sarell and Haney 2000).

Foraging habitats are much more prone to disturbances and the alteration of these habitats from urbanization, agriculture, logging, and fire suppression may affect foraging behaviour and prey capture success.

Threats

Population threats

Although its range is widespread across western North America, the Spotted Bat is rarely abundant and individual populations appear disjunct. This is especially true of the Thompson and Fraser Canyon populations. Populations are most susceptible to declines from prolonged disturbances at, or near roosts. Spotted Bats seem to be one of the bats most affected by disturbances (e.g., physical harassment, noise, vibration) and have abandoned roost sites when disturbed (O'Farrell 1975).

Pesticide use may cause reductions or contamination of prey items (Balcombe 1988). Because spotted bats are insectivorous they may be sensitive to bio-amplification of insecticides (Balcombe 1988).

Habitat threats

Cliffs used as night roosts can be affected by rock climbing, lighting, road construction and road traffic, flooding from dam construction, and mineral extraction. Urbanization is the primary factor in the loss of foraging habitat as extensively lit areas are avoided. Timber harvesting may cause disturbances leading to roost abandonment if in the immediate proximity of the roost. Road construction and the subsequent traffic, especially at night, may also interrupt foraging behaviour. Water sources are important and in short supply in arid environments.

Legal Protection and Habitat Conservation

The Spotted Bat is protected, in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act*.

Several important roost sites are located in parks (Vaseux Bighorn National Wildlife Area, Haynes Lease Ecological Reserve) and other conservation holdings managed by the Canadian Wildlife Service and The Nature Trust of BC (McIntyre Bluff). Many roosts are located within provincial forests, Indian reserves, and private lands.

Until the recent designation of two grassland parks, only 5% (8340 ha) of suitable Spotted Bat habitat in the south Okanagan was designated as conservation lands, and 43% (67 384 ha) was found on provincial Crown land (MELP 1998). The remaining habitat is on Indian Reserves or private land.

The wildlife habitat feature designation under the results based code could be used to address the roosting habitat requirements of this species. Riparian management, landscape level planning and range use plans may address foraging habitats of this species.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

❖ Provide adequate representation of foraging habitat near roosting habitat.

Wildlife habitat area

Goal

Maintain roosting sites and foraging habitats.

Feature

Establish WHAs at known or likely roost sites and hibernacula if discovered.

Size

The size of the WHA should be related to the size of the roost feature (e.g., cliff face). It is expected that most WHAs will be about 5–10 ha but larger ones may be required at exceptional sites.

Design

The core of the WHA will consist of the roost cliff and talus base. The management zone should be 100 m around the roost cliff.

General wildlife measures

Goals

1. Minimize access.
2. Minimize disturbance, including audible or vibration disturbances, during critical times.
3. Maintain all known roosting sites and hibernacula.
4. Maintain foraging habitat and prey abundance.
5. Maintain suitable microclimatic regime for roosting and hibernating sites.
6. Maintain riparian areas in a properly functioning condition.

Measures

Access

- Do not develop roads. Avoid construction between March and October when bats are active. Rehabilitate temporary access roads immediately after use and use access control measures on roads that are required for operations.
- Do not remove rock or talus.

Harvesting and silviculture

- Do not harvest within the core area. Use selective harvest methods in the management zone. Retain veteran trees.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to meet GWM goals.
- Do not place livestock attractants within WHA.

Recreation

- Do not establish recreation sites or facilities within WHA.

Additional Management Considerations

Minimize impacts from recreational activities (i.e., rock climbing).

Information Needs

1. Further inventories for roost cliffs.
2. Location of hibernacula.

Cross References

Bighorn Sheep, Fringed Myotis, Prairie Falcon

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Badger

Taxidea taxus jeffersonii

Original[1] prepared by Ian T. Adams and Trevor A. Kinley

Species Information

Taxonomy

Of the seven species of badgers, only the "American" Badger, *Taxidea taxus* (Schreber), occurs in North America. The subspecific classification accepted by COSEWIC and the CDC follows that proposed by Long (1972) and accepted with no or few modifications by Banfield (1974), Hall (1981), Long and Killingley (1983), and Messick (1987). Based on skull morphology, pelage colour, and range, the four subspecies are *T. taxus berlandieri*, *T. taxus jacksoni*, *T. taxus jeffersonii*, and *T. taxus taxus*. Only *T. taxus jeffersonii* occurs in British Columbia.

Description

The most distinctive features of the Badger is its posture and head colouration. It is a squat carnivore weighing 6–12 kg, with dense, coarse hair reaching nearly to the ground, typically giving the impression of an animal with very short legs. The head is characterized by alternating black and white bands, including a white dorsal stripe, black immediately anterior to the eyes, white immediately posterior to the eyes, black on the cheeks, and white immediately anterior to the ears. Other aids to field identification include dark brown to black legs; mottled body hair of mixed white, black, grey, and brown; extremely long claws (front claws often in excess of 5 cm); and rapid burrowing when disturbed or in pursuit of food. The *jeffersonii* subspecies is distinguished by its range (below), reddish brown colouration, large size, and short dorsal stripe. See Long and Killingley (1983) for a detailed morphological description, including subspecific characteristics.

Distribution

Global

The American Badger occurs only in central and western North America, from southern Canada to northern Mexico. Hall (1981) indicates the *jeffersonii* subspecies to occur from the Rockies westward as far north as southern British Columbia and as far south as the southern parts of Colorado, Utah, Nevada, and California.

British Columbia

Badgers occur within the drier parts of the Kootenays, southern interior, and central interior. The southern boundary follows the U.S. border from Alberta to the Similkameen River headwaters. The approximate western limit is the Cascade Mountains and middle section of the Fraser River (except in the lower Chilcotin drainage). The northern limit approximates a line from Alexis Creek to Quesnel Lake. The eastern boundary follows the west edge of the Cariboo and Monashee mountains to Lower Arrow Lake, then east across the Selkirk Mountains to Kootenay Lake, then north through the Purcell Mountains, Rocky Mountain Trench and Rocky Mountains to the Trans-Canada Highway, then east to the Alberta boundary and southeast along the provincial border.

Forest regions and districts

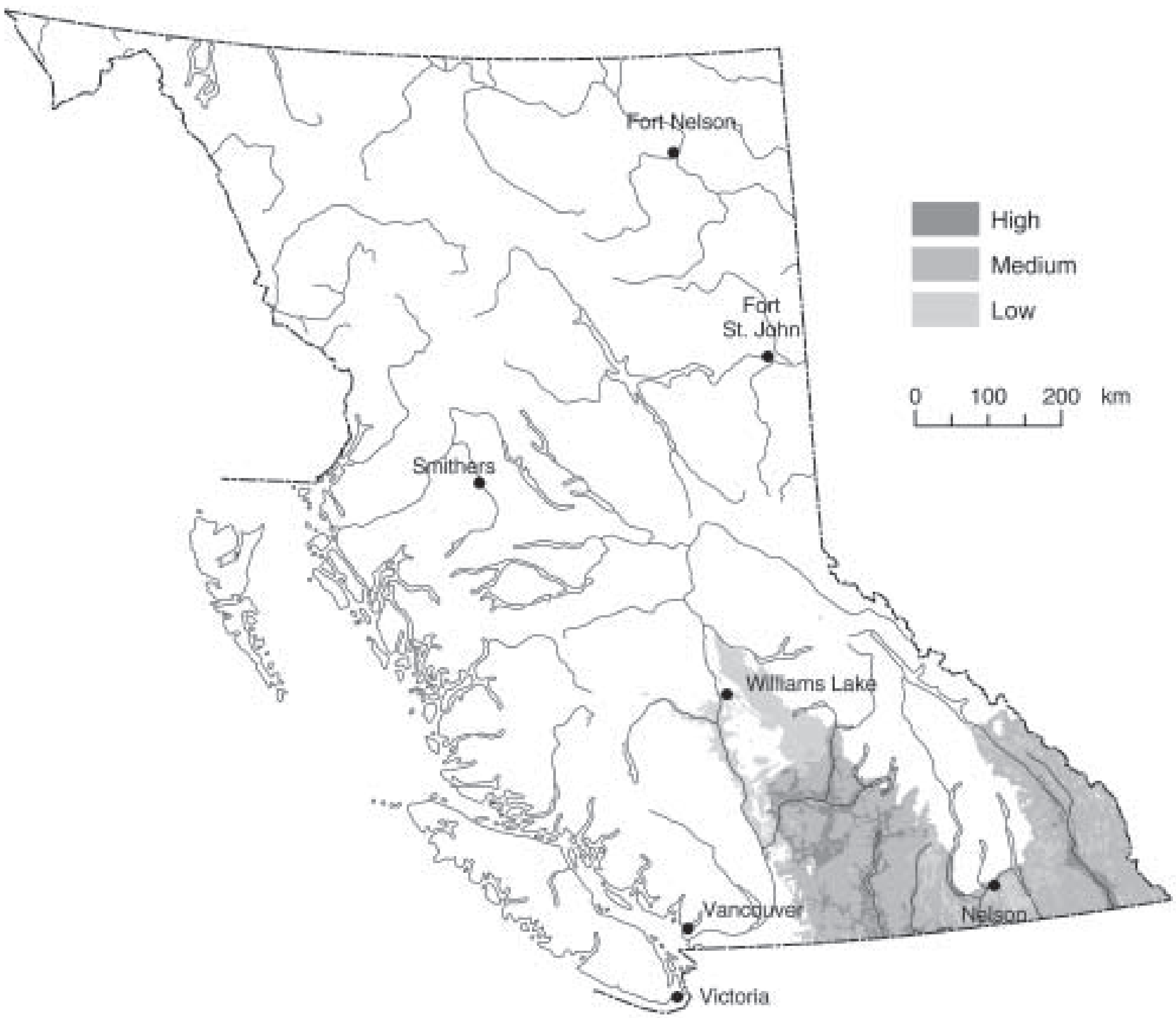
Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin (extreme east-central only), Columbia (southeast only), Headwaters (south only), Kamloops, Kootenay Lake (south only), Okanagan Shuswap, Quesnel (extreme south-central only), Rocky Mountain

Coast: Chilliwack (extreme east only)

1 Draft account for Volume 1 prepared by L. Gyug.

Badger

(Taxidea taxus)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Ecoprovinces and ecosections

CEI: CAB, CAP, CHP (lowest elevations only), FRB

SIM: COC, EKT, EPM, FLV, MCR, SCM, SFH, SHH (extreme south only), SPK

SOI: HOR, NOB, NOH, NTU, OKR, PAR, SOB, SOH, STU, THB

Biogeoclimatic units

AT

BG: xh1, xh2, xh3, xw, xw1, xw2

ESSF: dc1, dc2, dcp, dk, dkp, mw, mwp, wc1, wc4, wcp, wm, wmp, xc, xcp

ICH: dw, mk1, mk2, mk3, mw1, mw2, mw3, xw

IDF: dk1, dk2, dk3, dm1, dm2, mw, mw1, mw2, un, xh1, xh2, xm, xw, xw2

MS: dk, dm1, dm2, un, xk

PP: dh1, dh2, xh1, xh2

SBPS: mk

SBS: dw1, dw2, mc1, mm, un

Broad ecosystem units

Southern Interior Forest: AC, DF, DL, DP, EF, IG, IH, IS, PP, RB, RD, SD

Central and Northern Forest: LP, SF, SL

Subalpine Parkland and Krummholz: FP, WB

Shrub and Herb Dominated: AB, BS, MS, SS

Non-forested Subalpine and Alpine: AG, AM, AT, SG, SM

Sparsely Vegetated: UV

Urban and Agricultural: CF, MI, OV, RM, TC, TR, UR

Elevation

Badger occurrence is usually greatest near valley bottoms but at least some populations make regular use of all elevations, including the alpine. Minimum elevations are 300–800 m, depending on the region, while the maximum elevation is about 2800 m.

Life History

Diet and foraging behaviour

Badgers are adapted to capturing fossorial prey, which is their primary diet in most locations (Lampe 1982; Salt 1976). However, badgers supplement their diet with a wide variety of mammals, birds, eggs, reptiles, amphibians, invertebrates, and plants (Messick 1987). Fecal and stomach samples have included Columbian Ground Squirrels, Yellow-bellied Marmots, Northern Pocket Gophers, Red-backed Voles, Deer Mice, Great-Basin Pocket Gopher, ungulates, insects, sparrows, Common Loon, leporid, sucker, salmonid, Yellow-Bellied Racer, Western Rattlesnake, Long-Toed Salamander, frog or toad, and unidentified remains (Newhouse and Kinley 2002; H. Davis, Artemis Wildlife Consultants, unpubl. data; C. Hoodicoff, Univ. Victoria, unpubl. data; D. Nagorsen, formerly Royal B.C. Mus., pers. comm.; N. Newhouse, Sylvan Consulting Ltd., unpubl. data).

Dens function as sites for resting, food storage, and parturition, and as central nodes from which foraging is based. In Utah, Lindzey (1978) found that only 15% of all dens used by badgers were dug immediately before their use and some dens were reused numerous times by the same badger. Newhouse (1999) noted that 60% of radio-locations were in reused burrows, and also documented different badgers using the same burrow at different times. Maternal dens differ from those used for diurnal resting in that they are more structurally complex with larger soil mounds at the entrance (Lindzey 1976). A high degree of individual and interannual variation in winter torpor has also been noted, with some individuals active throughout most of the winter and others remaining in one burrow for up to 98 days (Newhouse 1997).

Reproduction

Badgers are promiscuous, with breeding occurring in late July and August (Messick and Hornocker 1981). Implantation is delayed until February, with parturition occurring in late March or early April. Litter sizes range from one to five kits (Lindzey 1982). Litter sizes among radio-tagged females in the East Kootenay and Thompson-Okanagan have varied from zero to three, recorded 6–10 weeks post-partum, although members of the public have reported local litters of up to four (Newhouse and Kinley 2002; Weir and Hoodicoff 2002; N. Newhouse, Sylvan Consulting Ltd., unpubl. data).

Home range and movement

As of 2000, mean home ranges in the East Kootenay were 51 km^2 for females and 450 km^2 for males, based on the minimum convex polygon (MCP) method. Another subsample of badgers recently radio-tagged at the southern end of the East Kootenay appears to have considerably smaller ranges, but data are not yet complete. Mean home ranges in the Thompson-Okanagan region are similar to those in the East Kootenay (Weir and Hoodicoff 2002). Home ranges in British Columbia are much larger than those found in Idaho, Wyoming, and Illinois (2–44 km^2 based on MCP; Messick and Hornocker 1981; Minta 1993; Warner and Ver Steeg 1995).

Juvenile dispersal generally occurs in June through August, but cases of dispersal not occurring until the age of 1 year have been recorded (N. Newhouse, unpubl. data).

Habitat

Structural stage

For forested habitat types in which older structural stages are characterized by closed-canopy forest, structural stage is critical. In such cases, prey abundance can sometimes be very high in structural stages 0 and 1, but typically diminishes rapidly after that.

For open-canopied and non-forested habitat types, the importance of grassland structural stages varies according to local prey base. In areas where Columbian Ground Squirrels are present, vegetative structure may play a relatively insignificant role. However, where ground squirrels are not present, badgers are more reliant on microtine rodents (mice and voles). At these sites, mid- to late-seral, highly structured grasslands are important habitat features for badger prey.

Important habitats and habitat features

In British Columbia most badger activity is at low elevations in dry regions (BG, PP, IDF) within native or non-native grasslands, open forests of Douglas-fir or ponderosa pine, and disturbed sites such as roadsides and agricultural fields. However, badgers have also been documented using cutblocks, burns, early-seral forests of several species composition, other open sites in the ICH, MS, ESSF biogeoclimatic zones and parts of the SBPS and SBS and occasionally the AT (Apps et al. 2002; Weir and Hoodicoff 2002). Newhouse and Kinley (2000) documented individual male badgers regularly travelling between the IDF and the AT biogeoclimatic zones. Badgers are also adaptable by region and by season to a wide variety of food sources. Badgers appear to be relatively tolerant of human presence, as evidenced by their use of golf courses, abandoned buildings, and roadsides (Newhouse 1999), although there are presumably upper limits to the level of habitat alteration, number of movement barriers, or amount of direct human disturbance that badgers will tolerate.

Burrowing and foraging

Badger burrow and hunting sites are typically within sites dominated by grass, forbs, or low shrubs, either in non-forest, open forest, or very young forest. Badgers are typically found in or near colonies of prey species, such as Columbian Ground Squirrels or Yellow-Bellied Marmots. Ground squirrels appear to slightly favour sites with a preponderance of forbs relative to grass and shrubs. However, without these species, badgers may rely on more evenly dispersed microtine rodents.

A variety of soil types are used, but the most common types are moderately coarse-textured Brunisols with low to moderate (<35%) coarse fragment content, originating from glaciofluvial and glaciolacustrine parent material. Where available, Chernozems are probably also selected. Badgers that occur in areas with predominantly morainal deposits (e.g., ESSF, MS forests) may be limited to using disturbed soils (e.g., overburden, road fill) or small areas with glaciofluvial deposits in these areas. Although badgers sometimes burrow along disturbed road rights-of-way, the high mortality risk associated with such locations probably outweighs any habitat value there. Distance from other mortality or harassment risks such as dogs are another important habitat feature. Because badgers maintain and use several burrows over a large home range, identifying a burrow as "active" or "inactive" is difficult. Burrows are readily reused by both badgers and other species (e.g., Burrowing Owl).

Conservation and Management

Status

The Badger is on the provincial *Red List* in British Columbia. In Canada, it is listed as *Endangered* (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

The most recent estimate for badger numbers in the province is <200 breeding adults (Adams et al. 2002). This is considerably lower than an earlier estimate of 300–1000 (Rahme et al. 1995). It is not clear whether this difference is due to recent population declines or simply a lack of information with which to make the earlier estimate. Pelt records do indicate a much larger population historically, with 200–350 pelts reported annually from British Columbia in 5 years within the 1920s, and this presumably represents only a portion of the total kill (Adams et al. 2002). In addition, there are examples of badgers disappearing (or nearly so) from relatively large areas in the recent past, such as the apparent near extirpation of badgers from the upper Columbia Valley in the past decade. However, even within areas of relatively healthy badger populations, numbers likely oscillate somewhat with changes in prey densities. Thus, the medium- to long-term trend in badger numbers has been downward, with the short-term trend unknown.

In southeast British Columbia, the average annual mortality was 23% among adults and 45% among juveniles (<1 yr), with causes of mortality among study animals including roadkill, probable predation by cougar, train kill, old age, predation by bobcat, and unknown. Trapping and shooting also resulted in the death of untagged animals (Newhouse and Kinley 2002).

Habitat trends

Throughout the regions of British Columbia that were historically dominated by grassland, shrub-steppe, and open forest, habitat has been lost over the past century due to forest encroachment and in-growth (as defined by Kirby and Campbell 1999). In some places, the pace of such losses may have slowed somewhat in recent years with the initiation of habitat restoration burns. Within more densely forested areas, some habitat has been created temporarily through logging (particularly where new forests have been slow to regrow). However, in areas with moderate to short historic fire-return intervals, gains from forest harvesting have probably been outpaced by the prevention of forest fires and the replanting of trees after burns. Post-harvesting habitat is generally short lived due to current stocking densities and "free-to-grow" requirements. Habitat has also been lost to human settlement, highways, intensive agriculture, gravel/sand pits, hydroelectric reservoirs, and the elimination of ground squirrel colonies. Thus, both the short- and long-term trends in habitat have been downward.

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	BC	CA	ID	MT	OR	WA	Canada	Global
S4	S1	S4	S5	S4	S4	S5[a]	N4	G5[b]

a Badgers will soon be under review in Washington where wildlife managers have significant concerns over its status, especially close to the British Columbia border (H. Allen, pers. comm.).

b There is no global ranking for the Taxidea taxus jeffersonii subspecies. This rank reflects the global rank for the entire Taxidea taxus species.

Threats

Several threats exist to badgers and their habitat (Table 1). Some of these are historical and likely led to the initial decline in badger numbers across the province but have since been at least partially abated. Other threats continue or are increasing.

Population threats

A large proportion of known death of instrumented badgers results from highway mortality. Their vulnerability to roadkill is due to several factors:

- Badgers prefer open valley bottom habitats, where highways are most often constructed.
- Large home ranges (especially males) may increase the frequency of encounters with highways.
- Disturbed soils adjacent to highways are ideal digging substrates for both badgers and their prey.
- Prey densities may be higher near highways because rights-of-way are maintained in early successional, grassy stages.
- Badgers' fearless behaviour, typical of most mustelids, leaves them vulnerable to road kills.
- Badgers are most active at night, when drivers will have the most difficulty seeing a relatively small, low-to-the-ground animal.
- Badgers may use roadside ditches and right-of-ways as extensive linear movement corridors.

Extermination of prey species such as ground squirrels, marmots, and pocket gophers may reduce food available to badgers. Secondary effects from consuming poisoned prey may also have harmful results on badgers. Habitat degradation due to poor range practices has also likely led to reductions in prey species with subsequent effects on badger population levels.

Badgers are killed by landowners who either directly fear them or consider them nuisance animals whose diggings may damage machinery or pose a threat to livestock.

The observed low reproductive output in British Columbia may inhibit badgers' ability to recover from lowered population levels. Banci and Proulx

Table 1. List of probable continuing and historic threats to badger populations and habitat in British Columbia ranked by relative impact (predominant or contributing), spatial distribution of the threat (widespread or local), temporal impacts (chronic, episodic, or ephemeral), and degree to which the threat has been reduced. (Source: Adams et al. 2002).

Threat	Impact	Spatial	Temporal	Continuing
Trapping	predominant	widespread	episodic	yes
Persecution	contributing [a]	widespread	chronic	partially
Urban development	predominant	widespread	episodic	increasing
Cultivation	contributing	widespread	chronic	no
Viniculture & orchards	contributing	local	chronic	no
Forest in-growth & encroachment	contributing	widespread	chronic	partially
Reservoir flooding	contributing [b]	local	chronic	no
Highway mortality	predominant	widespread	chronic	increasing
Extermination of prey	contributing	widespread	episodic	no
Secondary poisoning via prey	contributing	local	ephemeral	partially

a Degree of persecution is unknown. Impact is potentially substantial at a local level.

b Across all of British Columbia, reservoir flooding has likely had limited impact on population numbers. However at a local level (e.g., Lake Koocanusa in southern Rocky Mountain Trench), impacts are likely predominant.

(1999) classified the badger as a low resiliency species in British Columbia (i.e., with a low capability to recover from a reduction in numbers). They attribute the low resiliency to the fact that badger populations have a relatively low reproductive rate, extensive dispersal movements, and high human-caused mortality other than trapping. Human-caused mortality should be kept to a minimum (i.e., <10%) (Banci and Proulx 1999).

Habitat threats

There are several threats to badger habitat, including:

- highway construction
- urban development
- cultivation agriculture
- viniculture and orchard development
- forest in-growth and encroachment
- gravel and sand pits
- reservoir flooding
- poor range practices
- unfettered motorized access to grassland and open-forest ecosystems

Many of these threats present semi-permeable barriers to badgers. They readily cross highways; are known to swim across reservoirs; and will use cultivated fields, orchards, and ginseng farms. However, all of these represent varying degrees of habitat degradation, often as a result of reduced prey availability and increased mortality risk.

An important aspect regarding badger habitat loss is that impacts are exacerbated by negative human attitudes toward badgers. Badgers have been sighted at golf courses, ginseng farms, mine sites, ski hills; and within urban areas. However, humans tend to be intolerant (sometimes fearful) of badgers and either exterminate them directly or remove their prey.

Legal Protection and Habitat Conservation

Badgers have been protected from trapping and hunting under the provincial *Wildlife Act.* However, under Section 26 of the *Wildlife Act*, any species not listed as threatened or endangered and deemed to be a menace to domestic animals or birds may be killed by the property owner. Although red-listed by the B.C. Conservation Data Centre, badgers are not formally listed as threatened or endangered under the *Wildlife Act*.

Most prey species, including Columbian Ground Squirrel, Yellow-bellied Marmot, Northern Pocket Gopher, *Peromyscus* spp., and arvicolid rodents (voles) are protected on Crown land. However all are listed under Schedule B of the designation and exemption regulations of the *Wildlife Act* and may be legally killed on private land to protect property.

Protected areas currently provide little conservation value. In the East Kootenay region, protected areas represent 15% of the area available, but only 3% of probable badger habitat (Apps et al. 2002). Conversely, private lands represent 9% of the study area, but 35% of probable habitat (Apps et al. 2002). Despite new protected areas in the Okanagan region, a similar situation exists there. Further, badger home ranges are larger than most protected areas with probable badger habitat.

Large protected areas with suitable badger habitat include Kootenay National Park, Kikomun Creek Provincial Park, Lac du Bois Grasslands Provincial Park, Okanagan Mountain Provincial Park, White Lake Grasslands Provincial Park, and South Okanagan Grasslands Provincial Park. Outside of these parks, no significant habitat conservation actions have been taken specifically for badgers although badgers have been identified as part of the rationale for acquisition of conservation lands by non-profit organizations, and for restoring habitat within landscapes historically dominated by open habitats.

A functioning *jeffersonii* badger Recovery Team is in place under provincial jurisdiction with the B.C. Ministry of Water, Land and Air Protection as the lead agency. A draft recovery strategy (Adams et al. 2002) is under review and actions toward increasing badger populations in British Columbia are under way.

The Wildlife Habitat Feature designation under the results based code may be sufficient to protect and maintain badger burrows, especially maternal dens, provided that a 20-m radius (or one tree length, whichever is less) around the burrow is kept free of machinery impacts and soil disturbance. Characteristics or evidence of a maternal den include larger than average burrow (lots of dirt and signs of repeated use such as tracks, fresh digging), repeated sightings of adult badger within a small area, sighting of badger kits, and documented historic use. Burrows may also be protected on cutblocks using wildlife tree retention areas.

Livestock grazing practices on Crown rangelands should adhere to prescribed range use plans as administered by the Ministry of Forests under the results based code.

Identified Wildlife Provisions

Sustainable resources management and planning recommendations

The highest quality badger habitats occur in Natural Disturbance Type 4 (NDT4). Sites are characterized by:

- frequent, stand-maintaining fires
- generally open grassland or sparsely treed areas
- high densities of prey populations
- Brunisol and Chernozem soil types with fine sandy loam structure (generally friable soils without large rocks).

The focus of the following recommendations and measures are based on management in these areas. However, badgers in British Columbia are known to use NDT3 sites that have not been restocked, often following logging operations or severe fires. These NDT3 sites may represent a significant portion of the provincial badger population but are much more difficult to manage under current fire suppression, restocking, and Free-to-Grow requirements.

- ❖ Maintain areas of high habitat value for badgers.
- ❖ Maximize connectivity between areas of higher habitat value by minimizing urbanization and conversion of agricultural land to residential, industrial, or other developments.
- ❖ Maintain seral stage and structure on all habitats to support prey base.
- ❖ Maintain lowest possible road densities.
- ❖ Continue/increase restoration activities that reduce forest in-growth and encroachment.
- ❖ Reduce re-stocking rates in NDT4 zones (no planting wherever possible).
- ❖ Create and maintain a range of successional and structural stages of grassland and open forest ecosystems with structure and cover attractive to ground squirrels and other prey species.
- ❖ Leave larger, older trees to provide more ecological stability.

Wildlife habitat area

Goal

Protect critical habitat such as concentrations of burrow sites, especially maternal dens, and concentrations of prey species or friable soil habitat.

Feature

Establish WHAs in areas identified as critical badger habitat (e.g., concentration of burrows, abundant prey sources, and localized preferred friable soil types including moderately coarse-textured Brunisols originating from glaciofluvial and glaciolacustrine parent material) by the Regional Recovery Action Groups established by the National Recovery Team.

Size

Generally 2–100 ha, depending on site characteristics such as badger population density, soil types, number of burrows, and frequency of use.

Design

Design WHAs to include known burrows and/or prey concentrations and areas of suitable habitat. Use soil or geologic boundaries wherever possible.

General wildlife measures

Goals

1. Maintain important habitat features including sufficient structure/litter to provide hiding cover, open- or non-forested land, grasslands in a range of seral stages, friable soils, and prey.

2. Control forest encroachment and in-growth.
3. Manage livestock grazing to maintain suitable habitat for prey species (Columbian Ground Squirrel, Yellow-bellied Marmot, microtine rodents).
4. Minimize disturbance during the breeding season.

Measures

Access

- Do not develop any new road access.
- Restrict access to active maternal areas between 1 May and 15 August. Active areas may be identified by observed sightings of family groups (>1 badger) or other means (e.g., radio-telemetry). Active closures need only be in place for the current season.
- Close all established roads after resource extraction is completed.

Harvesting and silviculture

- Harvest as required to support ecological restoration. Reduce stocking densities (<75 stems/ha; target of 20 stems/ha) and free-to-grow requirements.
- Leave a selection of live and dead trees to maintain site ecology.

Pesticides

- Do not use pesticides.

Range

- Do not place livestock attractants in WHA.
- Manage livestock grazing to ensure proper conditions (seral and structural stages) for prey species. Conditions will vary depending on the prey species present.

Additional Management Considerations

Where appropriate, apply restoration treatments to maintain/create grassland and open forest conditions suitable as badger habitat.

Where feasible, maintain disturbed, early seral NDT3 sites as badger habitat by delaying and/or reducing restocking.

Encourage private land stewardship.

Protect prey species. Do not use rodenticides.

Off-road vehicle use (e.g., ATVs) should be restricted in areas of high badger use.

Information Needs

1. Predator–prey interactions including ecological requirements of various prey species, importance of Columbian Ground Squirrels as prey; implications of range/forest management strategies on prey species.
2. Distribution and abundance of badgers beyond Thompson and East Kootenay regions.
3. Contribution of NDT3 and alpine sites to provincial badger population, habitat supply, and connectivity.

Cross References

Bighorn Sheep, Burrowing Owl, "Columbian" Sharp-tailed Grouse, Grasshopper Sparrow, Long-billed Curlew, Racer, Sage Thrasher, "Sagebrush" Brewer's Sparrow, Sonora Skipper, Sooty Hairstreak, Western Rattlesnake, White-headed Woodpecker

antelope-brush–bluebunch wheatgrass, Douglas-fir–snowberry–balsamroot, ponderosa pine–bluebunch wheatgrass–silky lupine

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Fisher

Martes pennanti

Original prepared by Mike Badry[1]

Species Information

Taxonomy

Fishers (*Martes pennanti*) belong to the family Mustelidae (weasels). Fishers are considered to be a single undifferentiated species throughout their range (Powell 1993). Fishers are closely related to the other six members of the genus *Martes*: Eurasian Martens (*M. martes*), American Martens (*M. americana*), Yellow-throated Martens (*M. flavigula*), Japanese Martens (*M. melampus*), Sables (*M. zibellina*), and Stone Martens (*M. foina*). Fishers are sympatric throughout much of their range with American martens (Hagmeier 1956; Krohn et al. 1995), which are the only other *Martes* species found in North America.

Description

Fishers have long, thin bodies that are characteristic of most mustelids. Fishers have dense, long, luxurious, chocolate-brown coloured fur, with considerable grizzling patterns around the shoulders and back. Their tails are furred and make up about one-third of their total body length. Fishers have pointed faces, rounded ears, and short legs (Douglas and Strickland 1987). In British Columbia, adult females weigh on average 2.6 kg whereas males weigh 4.8 kg (R.D. Weir, unpubl. data). The average body length, excluding the tail, is 51 cm for females and 60 cm for males (Douglas and Strickland 1987). Fishers can be differentiated from American Martens by their larger body size (approximately 2–3 times larger), darker colouring, and shorter ears.

Distribution

Global

In North America, Fishers occur south of 60° N. They are distributed across the boreal forests and in southerly projections of forested habitats in the Appalachian Mountains and Western Cordillera (Douglas and Strickland 1987; Proulx et al. 2003). Fishers occur in most provinces and territories in Canada, except Newfoundland and Labrador, Nunuvut, and Prince Edward Island (Proulx et al. 2003).

The distribution of fishers in North America has probably been considerably reduced since pre-European contact (ca. 1600; Proulx et al. 2003). The current distribution of fishers has declined primarily in areas south of the Great Lakes region, but has also diminished in some areas of southeastern Ontario and Quebec, the Prairie Provinces, and in the western United States (Gibilisco 1994). The fisher has been extirpated from most of its former range in the western United States (Carroll et al. 1999).

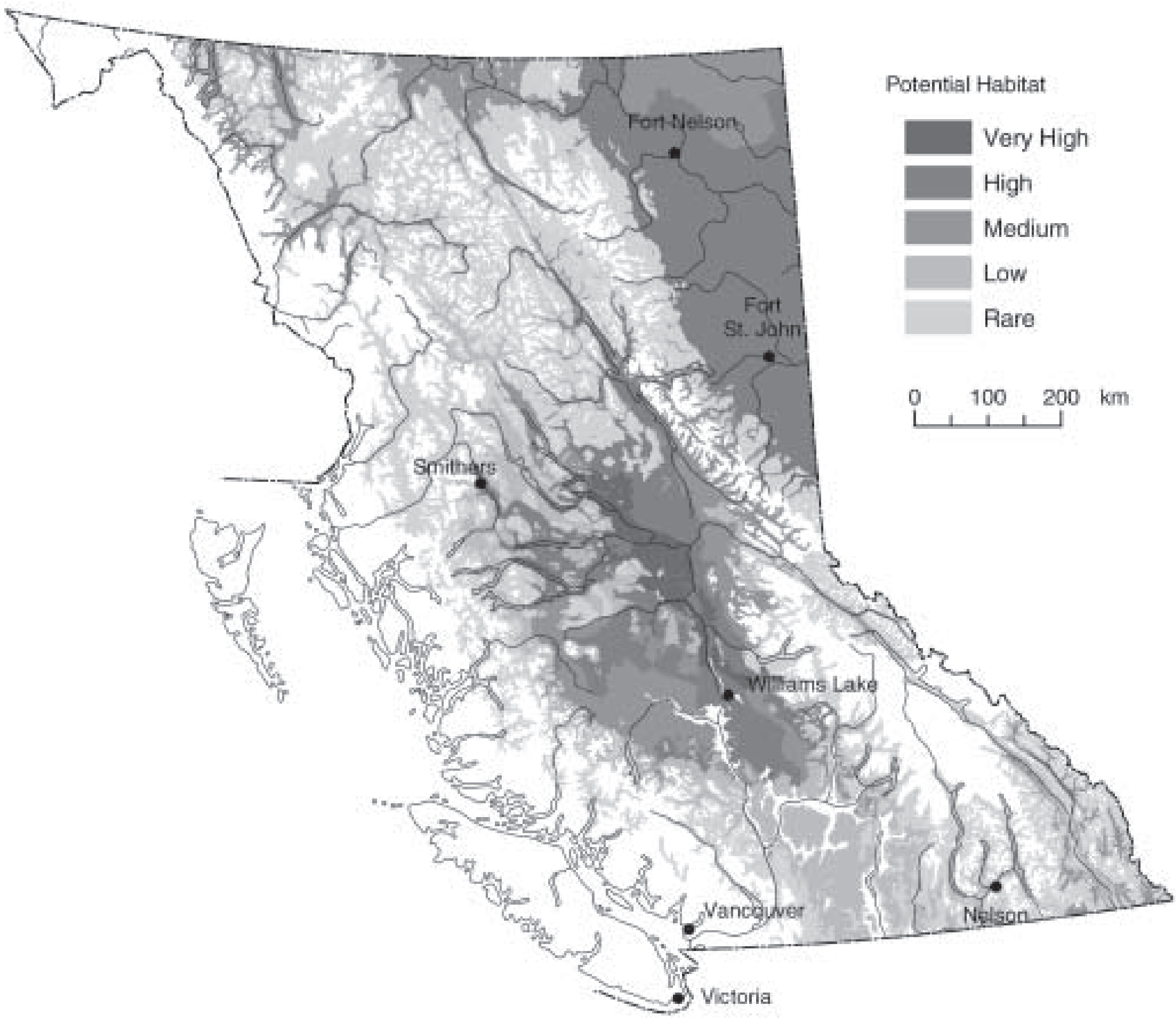
British Columbia

Although fisher occur throughout British Columbia, they are rare in coastal ecosystems. Fishers are currently believed to primarily occur in the Boreal Plains, Sub-Boreal Interior, Central Interior, and Taiga Plains ecoprovinces (Weir 2003). Fisher populations probably have very limited distribution in some portions of the Coast and Mountains, Southern Interior Mountains, Southern Interior, and Northern Boreal Mountains ecoprovinces and have likely disappeared from the Cascade and Okanagan Mountain ranges of the southern interior and in the Columbia and Rocky Mountain ranges south of Kinbasket Reservoir.

1 Account largely adapted from Weir 2003.

Fisher

(Martes pennanti)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

A reintroduction program of 61 fishers was conducted in the southern Columbia Mountains west of Cranbrook, which may have restored a small population of fishers in this region (Fontana et al. 1999).

Forest regions and districts

Coast: Campbell River, North Coast, North Island, Squamish, Sunshine Coast

Northern Interior: Fort Nelson, Fort St. James, Kalum, Mackenzie, Nadina, Peace, Prince George, Skeena Stikine, Vanderhoof

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin, Columbia, Headwaters, Kamloops, Kootenay Lake, Okanagan Shuswap, Quesnel, Rocky Mountain

Ecoprovinces and ecosections

BOP: all

CEI: all

COM: CPR, CRU, KIM, MEM, NAB, NAM

NBM: CAR, EMR, HYH, KEM, LIP, MUF, NOM, SBP, STP, TEB, TEP, THH, TUR, WMR

SBI: all

SIM: BBT, BOV, CAM, CCM, ELV, EPM, FLV, FRR, MCR, NKM, NPK, QUH, SFH, SHH, SPM, UCV, UFT

SOI: GUU, HOR, LPR, NIB, NOH, NTU, OKR, PAR, SCR, SOH, SHB, TRU

TAP: all

Biogeoclimatic units

BWBS, CWH, ESSF, ICH, MH, MS, SBPS, SBS, SWB (all possible subzones/variants)

IDF: dk3, dk4, dm1, dm2, dw, mw1, mw2, ww, ww2, xm

Broad ecosystem units

Broad ecosystem units of high value are IH, SD, RR, SF (interior locations only), and WR. Those of medium value are BA, BP, DF, DL, ER, HB, IS, and SL.

Elevation

Fishers tend to inhabit low to mid-elevations, up to 2500 m, and are not found at high elevations. Powell and Zielinski (1994) report that the majority of fishers are found below 1000 m and Banci (1989) indicates that fishers occur in middle range elevations. Fishers are likely confined to low elevations during periods of heavy snow (Powell and Zielinski 1994) and changes in elevation between seasons do not occur (Banci 1989).

Life History

Diet and foraging behaviour

Fishers are generalist predators and typically eat any animal they can catch and kill, although they may specialize on porcupines (*Erethizon dorsatum*) and snowshoe hares (*Lepus americanus*) in some areas (Powell 1993). Other reported foods include deer (*Odocoileus* spp., primarily as carrion), squirrels (*Tamiasciurus* and *Glaucomys* spp.), microtines, shrews (*Sorex* species), birds (mostly passerine and galliform), American martens, berries and other vegetation, and even fish and snakes (Coulter 1966; Clem 1977; Kelly 1977; Kuehn 1989; Arthur et al. 1989a; Giuliano et al. 1989; Martin 1994). Most foraging in winter occurs above the snow layer, and as such snow conditions likely influence foraging and distribution patterns. Summer foraging is strongly associated with coarse woody debris (CWD). Primary prey species are associated with abundant CWD and understorey shrub cover.

Diet is affected by several factors including prey availability, abundance, and size. Fishers are able to switch foods when populations of their primary prey fluctuate, permitting them to compensate for changes in prey availability.

Reproduction

Fishers have a reproductive system that results in a low reproductive output relative to their lifespan. Females produce at most one litter per year after they have reached 2 years of age (Douglas and Strickland 1987). Fishers are polygamous breeders, copulating with multiple conspecifics in early April.

Female fishers have an oestrus period lasting 2–8 days approximately 3–9 days following parturition (Hall 1942). A second oestrus cycle may occur within 10 days of the first cycle (Powell 1993).

Female fishers reproduce by delayed implantation (i.e., fertilized eggs lie dormant for approximately 10 months until implantation occurs; Douglas and Strickland 1987). This strategy is fairly common among mustelids (Mead 1994). Active development of the fetuses begins in middle to late February and lasts about 40 days (Frost et al. 1997).

The date of parturition varies throughout the range of fishers, but generally occurs between February and early April (Douglas and Strickland 1987). Reported parturition dates for fishers in British Columbia were between 23 March and 10 April (Hall 1942; Weir 2000). The mean date of parturition of radio-tagged fishers in the Williston region was 6 April (Weir 2000). Captive fishers in the East Kootenay region gave birth to litters between 17 March and 4 April (Fontana et al. 1999).

Fishers typically give birth to between one and three kits in late winter (Powell 1993), with a mean litter size of 2.7 kits (Frost and Krohn 1997). Fontana et al. (1999) recorded the sizes of 10 litters of captive females in British Columbia as ranging between 1 and 4 kits, with a mean of 2.6 kits. Actual reproduction in wild animals may be slightly lower; in Idaho, Jones (1991) estimated the average litter size of four reproductive fishers from placental scars to be 1.5 kits. Estimates from data from fishers harvested in British Columbia in the early 1990s indicated that the mean maximum number of kits per adult female was 2.3 (SE = 0.15; $n = 86$) during this time.

Female fishers typically give birth to their kits in natal dens. Newborn fishers typically weigh between 40 and 50 g and are completely dependent upon their mother for care (Powell and Zielinski 1994). Fisher kits are born with their eyes closed and they remain this way until 7–8 weeks of age. The mother supplies milk to her kits until they reach 8–10 weeks, after which she begins to provide them with solid food (Powell 1993). Fisher kits become mobile at 10–12 weeks, at which time they begin to leave their dens with their mothers (Paragi 1990). Kits travel with their mothers as they mature, presumably learning how to hunt prey and survive on their own. In Maine, kits were found to disperse from their natal home range in their first autumn (Arthur et al. 1993). However, data from the Williston region indicate that dispersal can occur later and successful establishment of home ranges may not occur until fishers are 2 years of age (Weir and Corbould, unpubl. data).

Site fidelity

Fishers are not widely reported to exhibit strong site fidelity, except for females with natal or maternal dens. On average, female fishers in Maine discontinued using maternal dens 71 days following parturition (Paragi et al. 1996). Female fishers may use between 1 and 5 maternal dens following abandonment of the original natal den (Paragi et al. 1996). Observations of natal dens being reused in subsequent years by fishers have been made in both the Williston and East Cariboo regions of British Columbia (Weir 1995, 2000).

Home range

Fishers are solitary and, other than mothers raising their young, they usually only interact with conspecifics during mating and territorial defence (Powell 1993). Fishers are aggressive and conspecific interactions may occasionally be fatal. The asociality of fishers is also exhibited in their spatial organization. Fishers tend to have intrasexually exclusive home ranges that they maintain throughout their lives. This is a common spacing pattern among mustelids (Powell 1979), in which home ranges of members of the same sex may overlap (Kelly 1977), but this is extremely rare among fishers (Arthur et al. 1989b).

Reported home range areas for fishers range from 4 to 32 km^2 for females and 19–79 km^2 for males. Powell (1994b) summarized the reported sizes of home ranges of fishers from across North America and derived a mean home range size of 38 km^2 for males and 15 km^2 for females. Estimates of home range sizes from Idaho and Montana suggest that the home range sizes of fishers are larger in western regions than in eastern and southern areas possibly because of lower densities of prey (Idaho, Jones 1991; Montana, Heinemeyer 1993). However, Badry et al. (1997) found that translocated fishers in

Alberta had home ranges of 24.3 km^2 and 14.9 km^2 for males and females, respectively, which were similar to home range sizes of fishers in eastern North America.

Weir et al. (in prep.) described the size and spatial arrangement of annual and seasonal home ranges for 17 radio-tagged resident fishers in two areas of central British Columbia. The annual home ranges of female fishers (= 35.4 km^2, SE = 4.6, n = 11) were significantly smaller than those of males (= 137.1 km^2, SE = 51.0, n = 3). Minor overlap was observed among home ranges of fishers of the same sex, but there was considerable overlap among home ranges of males and females. Home ranges that they observed in central British Columbia were substantially larger than those reported elsewhere in North America, particularly for males. Weir et al. (in prep.) hypothesized that the sizes of home ranges of fishers were relatively large because the density of resources in their study areas may have been lower than elsewhere. They also speculated that home ranges of fishers in their study areas were widely dispersed and occurred at low densities because suitable fisher habitat was not found uniformly across the landscape.

It is unclear what factors affect the size of home ranges in fishers, although it is likely that the abundance and distribution of resources play a critical role in determining home range size. Fluctuating prey densities, varying habitat suitability, and potential mating opportunities are all probably important factors that affect size of the home range. There is likely a lower density at which these resources become limiting which would result in abandonment of the home range (Powell 1994b).

Movements and dispersal

Very little is known about dispersal in fishers because few studies have been able to document this process. In eastern portions of their range, researchers have reported that fishers disperse from their natal home ranges during their first winter and establish home ranges in unoccupied habitats soon afterward (Arthur et al. 1993; Powell 1993). Information from the Williston region suggests that home range establishment may not necessarily occur at this time and may be delayed until fishers reach 2 years of age (R.D. Weir, unpubl. data).

Some evidence suggests that fishers may have poor dispersal capability. Arthur et al. (1993) observed that dispersing juveniles in Maine did not typically establish home ranges more than 11 km from their natal home ranges. A juvenile male fisher in the Williston region moved 20 km from its initial capture location to its eventual home range (Weir 1999). The low degree of relatedness among fisher populations across Canada, and in particular the East Cariboo and Omineca regions of British Columbia, as identified by Kyle et al. (2001), supports this hypothesis of low dispersal capability.

Despite the relatively short distances over which fishers have been documented to successfully disperse, fishers appear to be capable of moving widely through the landscape. A fisher with a radio-collar was photographed using a wildlife overpass in Banff National Park; over 200 km from the nearest radio-telemetry study (T. Clevenger, pers. comm.). A radio-tagged juvenile fisher in the Williston region travelled at least 132 km and covered over 1200 km^2 before it died 77 km from where it was first captured (Weir 1999). Weir and Harestad (1997) noted that translocated fishers in central British Columbia wandered widely throughout the landscape following release and covered areas of more than 700 km^2 while transient. They also observed that major rivers and other topographic features were not barriers to movements throughout the landscape.

The apparent contradiction between short successful dispersal distances and considerable movement potential of fishers may be because effective dispersal is dependent upon many factors in addition to the ability to move through the landscape. Suitable habitat and prey, avoidance of predators and other mortality agents, and the presence of conspecifics can all act in concert to affect successful dispersal.

The process of dispersal is integral to the persistence of fisher populations because fisher populations are inherently unstable (Powell 1994b) and are probably characterized by periods of local extinction and recolonization (Powell 1993). Thus, the ability of individuals to successfully disperse to unoccupied habitats is important for population persistence. Arthur et al. (1993) speculated that the short distances over which fishers dispersed in Maine could limit the ability of the species to recolonize areas where fishers have been extirpated. This relationship between recolonization and dispersal ability may hold true in British Columbia, but information on this is lacking.

Fishers move about their home ranges in their day-to-day activities of acquiring resources. With the exception of females maintaining natal or maternal dens, fishers do not base their activities from any one central point in their home range (Powell 1993). Fishers can typically cross their home range in 16 hours and travel up to 5–6 km/day (Arthur and Krohn 1991), although transient individuals have been observed moving up to 53 km in <3 days (Weir and Harestad 1997). Early snow-tracking studies suggested that fishers follow circuits of up to 96 km as they wander through their home range, although their movements may not necessarily follow such predictable routes (de Vos 1952). Arthur and Krohn (1991) noted that adult male fishers moved more widely during spring than any other season, presumably to locate potential mates.

Fishers typically have two or three periods of activity during the day (Powell 1993). In Maine, fishers were reported to have peaks in activity primarily in the early morning before sunrise and in the evening shortly after sunset (Arthur and Krohn 1991). Approximately half of all radio-locations of fishers in the Williston region indicated that fishers were active, but there was no consistent trend in the timing of activity (R.D. Weir, unpubl. data). Reproductive female fishers with kits were more active than non-reproductive females despite nursing kits each day (Arthur and Krohn 1991; R.D. Weir, unpubl. data). Both cold temperatures and deep snow probably reduce the activity of fishers (Powell 1993; R.D. Weir, unpubl. data).

Deep, soft snow may also inhibit the movements of fishers during winter. Fishers are reported to modify their small-scale movements within stands to avoid areas with less-supportive snow (Leonard 1980; Raine 1983). Weir (1995) suggested that fishers in the East Cariboo region of central British Columbia used patches with large trees because the overstorey closure afforded by these trees may have increased snow interception.

Habitat

Structural stage

Fishers forage within many structural stages. Structural stages 1a (non-vegetated) through 3b (tall shrub) are not used during winter but may be used in other seasons providing sufficient forage and security cover is present. Most habitat use is associated with structural stages 6 (mature forest) and 7 (old forest) where structural characteristics of older forests are most developed. Resting and maternal denning habitat is typically associated with structural stages 6 and 7, and key features are availability of CWD, large wildlife trees, and canopy cover in winter. Fisher will forage in a wider range of structural stages (particularly in summer) and habitat use may be influenced by population cycles of major prey species.

Important habitats and habitat features

In western coniferous-dominated forests, fishers appear to have affinities to specific habitat features, many of them found primarily in late-successional forests (Jones and Garton 1994; Weir 1995). Aspects of forest structure are likely more important determinants of distribution and habitat use than are forest types.

In British Columbia, preferred habitat resembles that found in SBS, SWB, and BWBS biogeoclimatic zones and more specifically riparian and dense wetland forest habitats within those zones. Fishers generally stay in or near forests with ^{3}30% canopy closure with a productive understorey that supports a variety of small and medium-sized prey species. The presence of suitable resting and maternal den sites is also important as is riparian-riparian and riparian-upland connectivity.

Resting

Fishers use rest sites for a variety of purposes, including refuge from potential predators and thermoregulatory cover (Kilpatrick and Rego 1994). Fishers have been reported to use a wide variety of structures as rest sites, including tree branches, tree cavities, in or under logs (hollow or solid), under root wads, in willow (*Salix* spp.) thickets, in ground burrows, and in rock falls (Raine 1981; Arthur et al. 1989a; Jones 1991; Powell 1993; Kilpatrick and Rego 1994; Gilbert et al. 1997).

Weir et al. (2003) identified four distinct types of structures used for resting by fishers in British Columbia: branch, cavity, CWD, and ground sites. Branch rest structures were arboreal sites that typically involved abnormal growths (i.e., brooms) on spruce trees caused by spruce broom rust (*Chrysomyxa arctostaphyli*) or on subalpine fir trees caused by fir broom rust (*Melampsorella caryophyllacearum*). Occasionally branch rest sites associated with exposed large limbs of black cottonwood (*Populus balsamifera trichocarpa*) and spruce (*Picea* spp.) trees were used. Cavity rest structures were chambers in decayed heartwood of the main bole of black cottonwood, aspen, or Douglas-fir (*Pseudotsuga menziesii*) trees; cavities were accessed through branch-hole entrances into heart-rot (black cottonwood, aspen [*Populus tremuloides*], or Douglas-fir trees) or excavations of primary cavity nesting birds (aspen trees only). Coarse woody debris rest structures were located inside, amongst, or under pieces of CWD. The source of CWD for these sites was natural tree mortality, logging residue, or human-made piling. CWD rest structures were usually comprised of a single large (>35 cm diameter) piece of debris, but occasionally involved several pieces of smaller diameter logging residue. Ground rest structures were those that involved large diameter pieces of loosely arranged colluvium (e.g., rock piles) or pre-excavated burrows into the soil. Weir et al. (2003) recorded fishers using branch rest structures most frequently (57.0%), followed by cavity (19.8%), CWD (18.6%), and ground (4.6%) rest structures.

The selection of rest sites by fishers may be mediated by ambient temperature. Weir et al. (2003) noted fishers used subnivean CWD rest structures when ambient temperatures were significantly colder than when they used branch and cavity structures. The thermal attributes of the four types of rest sites used by fishers in their study likely affected their respective selection and may help explain the patterns that they observed. Taylor and Buskirk (1994) measured and calculated the thermal properties of branch, cavity, and CWD sites in high-elevation forests of southern Wyoming. They found that CWD sites provided the warmest microenvironments during periods of cold temperatures (<–5ºC), deep snowpack (>15 cm), and high wind speed. Branch or cavity sites were warmer during all other combinations of ambient temperature, snowpack, and wind (Taylor and Buskirk 1994). Although it is unlikely that fishers in British Columbia encounter temperatures that are near their estimated lower critical temperature for resting, they likely select rest structures that are the most energetically favourable to help maximize their fitness. Fishers in British Columbia exclusively used subnivean CWD structures for the energetic benefits that they confer relative to other structures when temperature were below –15ºC (Weir et al. 2003). Fishers probably use branch and cavity structures for resting during most of the year because these sites provide an adequate thermal environment for most combinations of ambient temperature and wind speed.

Reasons for selecting specific rest structures probably change seasonally and thermoregulation is likely not the only factor that affects the selection of rest sites by fishers. Several authors have suggested that fishers rest close to food sources (de Vos 1952; Coulter 1966; Powell 1993). There are more suitable resting sites in trees than on the ground (Martin and Barrett 1991); hence, fishers may select tree sites because of their relative availability. Additionally, Raphael and Jones (1997) speculated that arboreal structures offer greater protection from predators than do ground sites. Because of their elevated position, tree sites may also enhance olfactory or visual discovery of approaching predators. Similarly, elevated sites may improve detection of potential prey, while providing areas for avoiding predators. Thus, in the absence of restrictive thermoregulatory demands, fishers probably select structures based upon these other factors.

Breeding

Female fishers appear to have very specific requirements for structures in which they rear their kits. Natal (i.e., whelping) and maternal (i.e., rearing) dens of fishers are typically found in cavities, primarily in deciduous trees (Powell 1993; Weir 2000). Leonard (1980) hypothesized that dens were situated in tree cavities because they provide thermal benefits and are more defendable. Female fishers use between one and five maternal dens following abandonment of the original natal den (Paragi et al. 1996). In eastern parts of their range, fishers have been documented whelping in a variety of hardwood trees (Maine: median diameter = 45 cm, Paragi et al. 1996; New England: = 66 cm, Powell et al. 1997; Wisconsin: = 60.9 cm, Gilbert et al. 1997). In contrast, recent work by Aubry et al. (2001) has identified fishers in southwestern Oregon using cavities and witches' brooms in coniferous trees (Douglas-fir, incense cedar [*Calocedrus decurrens*], grand fir [*Abies grandis*], western white pine [*Pinus monticola*], and sugar pine [*Pinus lambertiana*]) and logs as natal and maternal dens.

In British Columbia, fishers have been recorded whelping in trees that are atypically large and uncommon across the landscape. Researchers have identified 11 natal and eight maternal dens of radio-tagged fishers, all of which were located in large diameter (= 105.4 cm), declining black cottonwood or balsam poplar (*Populus balsamifera balsamifera*) trees (R.D. Weir, unpubl. data). Den cavities in these large trees were, on average, 15 m above ground (R.D. Weir, unpubl. data).

Elements with these traits may be rare across the landscape, as indicated by observation of natal dens being reused by fishers in the both the Williston and East Cariboo regions (Weir 1995, 2000). Weir (1995) found that 98% of random points in his study area in the East Cariboo had either no cottonwood trees or ones that were smaller than the minimum diameter of any natal or maternal den trees. Thus, suitable cottonwood trees may be an important component in the selection of a home range by female fishers (Weir 1995). The reasons that fishers select this type of tree for whelping is likely related to the decay characteristics of deciduous trees, which produce heart rot and cavities much earlier and at smaller diameters than coniferous trees. The cottonwood trees that fishers in British Columbia use may be atypically large because they grow faster than eastern deciduous trees and rot earlier.

All of the natal and maternal dens identified in British Columbia consisted of holes through the hard outer sapwood into cavities in the inner heartwood (R.D. Weir, unpubl. data). Black cottonwood trees are prone to decay of the heartwood at an early age (Maini 1968), but data from British Columbia suggest that cottonwood trees may be suitable for use by fishers for rearing kits when the bole at the cavity height is >54 cm diameter (R.D. Weir, unpubl. data). Although the relationship between dbh and dbh of the den is unclear, it appears that cottonwood trees need to be >88 cm dbh; for the cavity to be used by fishers, cavity entrances may need to be >5 m above ground (R.D. Weir, unpubl. data). Thus, for fishers to use black cottonwood trees for natal or maternal dens, the trees may need to have heart rot and a bole diameter >54 cm at 5 m above ground.

Foraging

Fishers require the presence of "available" prey and adequate security cover to use habitats for foraging. Availability of prey is affected by not only the abundance of the prey, but also its vulnerability to predation (Buskirk and Powell 1994). Vulnerability is affected by the presence of escape cover for the prey, which can include such features as snow cover and highly complex vegetative structure. Fishers rarely use open areas for foraging (Raine 1981), and when crossing them, they usually run (Powell 1981). Sufficient overhead cover in a foraging habitat can be provided by tree or shrub cover (Weir 1995).

Suitable combinations of available prey and adequate security cover likely occur in a variety of habitat types, and thus, fishers have been reported to use a wide array of habitats for foraging. Researchers have documented fishers using deciduous forests for hunting porcupines (Powell 1994a), riparian zones for small mammals (Kelly 1977), and densely regenerating coniferous habitats for hunting snowshoe hares (R.D. Weir, pers. comm.).

Regardless of prey species, foraging by fishers is believed to involve two components: locating patches of habitat with prey and searching for prey items within these patches (Powell 1993). Fishers appear to have a cognitive map of where suitable patches of prey may be within their home range and visit these areas to hunt for food (Powell 1994a). The characteristics of these patches are likely related to the type of prey that use them; Powell (1994b) noted that fishers hunted for snowshoe hares in patches of dense lowland conifers and for porcupine dens in open upland habitats. Fishers use several very different strategies when searching for prey within patches, depending on the prey being pursued. When searching for high-density prey in complex structure, fishers hunt using frequent changes in direction, presumably to increase chance encounters with prey (Powell 1993). When using habitats with relatively low densities of prey, fishers travel in more-or-less straight lines but will deviate from these routes to opportunistically capture prey (Powell 1993). Unlike the American Marten, fishers are somewhat limited to foraging on the snow surface during winter and are relatively ineffective at catching prey beneath the snow (de Vos 1952; Powell 1993). It is unclear whether the foraging strategies that fishers use for different prey are dependent upon the prey species' respective vulnerability, abundance, or both.

Conservation and Management

Status

Fishers are on the provincial *Red List* in British Columbia. Its status in Canada has not been evaluated (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

The range reduction in the eastern part of the fishers range observed in the early 1900s has been attributed to wide-scale habitat alterations and overtrapping (Douglas and Strickland 1987). Fisher populations are believed to be stable or expanding in the central and eastern portions of its range (Proulx et al. 2003), likely because of reforestation of abandoned agricultural lands, trapping restrictions, and several reintroduction programs.

Very little is known about population trends of fishers in British Columbia and what little is known has been derived from harvest statistics. The harvest of fishers in the province has fluctuated widely since 1919. Generally, the annual harvest of fishers decreased during the 1970s and 1980s. In 1973–1974, 1747 fishers were harvested, while in 1990–1991 only 93 fishers were harvested. The mean annual harvest of fishers in British Columbia over the past eight trapping seasons was 276 fishers (SE = 17, range: 206–348). However, harvest information can be biased and dependent upon many other factors in addition to population size, such as trapper effort (which is affected by fur prices, economic alternatives, and access) and vulnerability to trapping (Banci 1989; Strickland 1994).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	AK	BC	ID	MT	NWT	OR	YK	WA	Canada	Global
S4	S?	S2	S1	S2	S?	S2	S?	SH	N5	G5

The Ministry of Environment collected 329 fisher carcasses from British Columbia between 1988 and 1993 to assess the harvest rate and population trends of fishers. Age, sex composition, and date of the harvest were determined from these carcasses. The harvest ratio during this survey was 1.34 juveniles per adult and 1.36 females per male. The low juvenile to adult female ratio in the harvest, in combination with a relatively low fecundity rate, suggests that the fisher population in British Columbia may have been declining in the early 1990s, despite a province-wide closure of the trapping season. Notwithstanding this possible decline, harvests of fishers since 1994 have remained relatively stable (about 275 fishers/yr). This may be due to the natural recovery of fisher populations following years of decline (Powell 1994b). Insufficient population inventory restricts our ability to assess the rate of decline or growth during the past 10 years.

A population estimate based on empirical data for fishers in British Columbia is lacking. However, a density estimate of one fisher per 146 km² from the Williston region can be extrapolated to other areas based upon habitat capability. The density estimate from the Williston region was derived for an area with 75% "moderately high" (SBSmk) and 25% "moderate" (SBSwk) habitat capability. These ranks are defined as areas that have densities between 51 and 75% (moderately high) and between 26 and 50% (moderate) of the benchmark density (RIC 1999). The benchmark is the highest capability habitat for the species in the province, against which all other habitats for that species are rated. It is used to calibrate the capability ratings by providing "the standard" for comparing and rating each habitat or ecosystem unit. Thus, using the Williston density of one adult fisher per 146 km², the provincial benchmark density for fishers would range between one fisher per 100 km² if the Williston estimate was 75% of the benchmark, and one fisher per 65 km² if the Williston estimate was 51% of the benchmark. Using the area of each habitat capability rank within the extent of occurrence of fishers in British Columbia, the late-winter population estimate for the province extrapolates to between 1113 and 2759 fishers.

Habitat trends

Habitat for fishers in British Columbia has undergone considerable anthropogenic change during the past 100 years. Habitat alterations, primarily through forest harvesting activities, hydroelectric developments, and land clearing, have changed the composition of many landscapes in which fishers occur. Because fishers rely on many of the habitats that are directly affected by these activities, these changes have likely had considerable effect on fisher populations in the province.

Hydroelectric developments have eliminated fisher habitat in several areas of the province. Flooding typically inundates, and thus removes, substantial portions of the riparian habitat that is found within a watershed. In the Williston region for example, the most productive habitats for fishers appear to be the late-successional riparian habitats that occur alongside meandering rivers (Weir and Corbould, unpubl. data). Much of this habitat in the region was removed with the flooding of 1773 km² of the Rocky Mountain Trench during 1968–1970 to create the Williston Reservoir. Almost 700 km² of "moderately high" capability habitat was flooded during the creation of the Ootsa Reservoir on the Nechako River. Similarly, flooding of ~700 km² of valley bottom habitats of the Columbia River likely removed much of the capable habitat for fishers in many areas of the Kootenay region (B. Warkentin, pers. comm.). The removal of these habitats from the land base has probably had highly localized negative effects on fisher populations in these areas.

Other human developments have diminished the quantity of fisher habitat in many areas of the province. Urban and semi-rural development associated with cities and towns in central British Columbia has probably reduced the quantity of habitat for fishers in some small portions of their range. Development of valley bottoms for agricultural operations has occurred extensively along the Nechako, Bulkley, and Fraser rivers. Clearing of land over the past 100 years for these activities has probably been detrimental to fisher populations because it removed most of the structures that fishers need for overhead cover, resting, whelping, and foraging. Development of valley bottom habitats in the Skeena region was thought to have effectively removed much of the suitable habitat for fishers (G. Schultze, pers. comm.).

Forest harvesting has probably had the greatest single effect on habitat quality for fishers throughout the province. During the last 15 years, over 213 000 km^2 of forested land has been harvested in the four forest regions that support fisher populations in the province. Of this 213 000 km^2, over 90% was logged using clearcut harvesting systems. Although a substantial portion of this area was probably outside of areas occupied by fishers, modification of late-successional forests into early structural stages through this type of forest harvesting has likely had detrimental effects on the ability of fishers to acquire sufficient resources to survive and reproduce.

Additionally, forests in considerable portions of the Fisher's range in British Columbia are currently experiencing substantial tree mortality caused by outbreaks of the mountain pine beetle (*Dendroctonus ponderosae*) and other insects. In the Prince George Forest Region alone, over 25 000 km^2 of forests are currently under attack from insects (MOF 2002), an area that is more than the total area that has been logged in the Cariboo, Kamloops, Prince George, and Prince Rupert forest regions combined over the past 15 years. Reduction in overhead cover in these areas may be detrimental to Fishers. However, wide-scale harvesting of these forests as part of salvage operations would likely contribute to a substantial decrease in the availability and suitability of Fisher habitat in the both the short and long term (G. Schultze, R. Wright, pers. comm.).

Threats

Population threats

Trapping has the potential to affect populations of Fishers by changing mortality rates and the reproductive potential of the population. Trapping of adults could exacerbate difficulties in Fishers successfully finding mates, which could potentially reduce the reproductive rates within the population. Trapping mortality may be compensatory for the juvenile cohort at moderate harvest intensities (Krohn et al. 1994), but the rate of harvest at which this mortality becomes additive is unknown. Trapping mortality within the adult cohort is probably additive to natural rates (Strickland 1994). Because Fishers typically do not breed until 2 years of age, maintaining this cohort is very important for population health.

Banci and Proulx (1999) identified Fisher populations as having low to intermediate resiliency to trapping pressure, which means that Fisher populations generally have a moderate capability to recover from a reduction in numbers. However, this assessment was primarily based on information from eastern parts of their range. Information specific to British Columbia suggests that fishers in this province have more limited range or distribution, lower reproductive rates, and larger home ranges than Fishers in other areas. These factors suggest that Fisher populations in British Columbia may have a lower resiliency to trapping than populations elsewhere.

Habitat threats

In an extensive review of the worldwide distribution of *Martes* species, Proulx et al. (2003) identified loss of forested habitat from human development as the main long-term threat to fisher populations throughout its range. For a species like fishers with large spatial requirements, the long-term maintenance of extensive forestlands will be the major conservation challenge (Proulx et al. 2003.) This risk is probably even greater in British Columbia, where the home ranges of fishers are larger and the density lower than in other portions of their range.

Forestry activities can affect the quality of fisher habitat in many respects. First, timber harvesting typically removes many of the features of late-successional forests that fishers rely upon, such as large spruce trees, and replaces them with stands that have fewer structural components and are of lower suitability (Weir 1995). Second, forest harvesting may negatively affect the distribution of the remaining habitat so that fishers have to search more widely to sequester sufficient resources. Third, the concomitant increase in access that occurs with forest harvesting in previously inaccessible areas may increase trapping mortality, possibly diminishing "source" populations.

Prior to logging, many forests likely provided habitat structures that fishers require for resting and reproduction (e.g., large cottonwood trees, CWD, large spruce trees). Forest harvesting, which is targeted primarily at late-successional forests, has likely altered the availability of these resources across spatial scales. The reduced availability of these habitat features has probably resulted in previously occupied landscapes becoming unsuitable for fishers.

The quality of regenerating clearcuts to fishers varies tremendously depending upon the silvicultural systems that are implemented. Fishers use many features of late-successional forests to fulfil several life requisites. Thus, the supply of these features is probably critical to the survival and reproduction of fishers. Forest harvesting activities tend to remove many of these features and the resulting silvicultural management of the regenerating forests suppresses the development and recruitment of these structures in managed areas.

Many attributes that are the result of natural processes of growth, disease, and decay of forested stands appear to be important for providing habitat for fishers. Thus, management of forested land that emphasizes tree growth and suppresses disease, death, and decay of trees may negatively affect the quality of fisher habitat. Monotypic stands that are low in structural and plant diversity probably fulfil few life requisites for fishers because many habitat elements that fishers and their prey are dependent upon are missing in these habitats. Thus, maintaining structurally diverse and productive fisher habitat in logged areas is not only a function of the method and extent of timber harvesting, but also the type of site preparation and subsequent stand tending.

The effects of alterations in habitat quantity and quality on fisher populations probably depend upon the scale and intensity at which the changes have occurred. Because the stand is the dominant scale at which an individual fisher operates within a home range, loss of habitats at this scale or larger will likely preclude use of that area by fishers. Habitat loss at smaller spatial scales likely affects the energetics of individual animals because they have to travel more widely to find food and other resources.

The quality of harvested areas is likely substantially diminished for fishers under typical clearcut and intensive forest management practices. With rotational forestry, many of the features of late-successional forests will be lost and not have the opportunity to regenerate. For example, large coniferous trees that are used by fishers for resting may vanish with short rotations (e.g., <100 yr). The retention of CWD within harvested sites may also be insufficient to supply cold-weather resting sites. Interspersion of deciduous trees for potential resting and den sites may disappear as they are removed during stand tending. Sufficient conifer cover may be present at the later stages of the rotation under intensive forest management.

Reductions in the quality and quantity of habitat for fishers will likely continue to occur in the future in British Columbia. Continued harvesting of late-successional forests using conventional clearcut harvesting at the 15-year average rate of 1422 km^2/yr will likely pose a substantial threat to fisher populations in the central interior of British Columbia.

Legal Protection and Habitat Conservation

Fishers are designated as wildlife in British Columbia under the *Wildlife Act* and cannot be hunted, trapped, or killed unless under license or permit. Fishers are also classified as "furbearers" and as such may be legally trapped under license during open seasons. Currently trapping seasons are open in the Thompson, Cariboo, Skeena, and Omineca/ Peace regions between 1 November to 15 February. There is no open season in the Lower Mainland, Okanagan, and Kootenay regions. Furbearing species in British Columbia can only be harvested by qualified personnel on private land or registered traplines (where one individual or group has the exclusive right to harvest furbearers in a specified area). There is no quota on the harvest of fishers in British Columbia.

Fishers in British Columbia occur primarily on Crown land administered by the Ministry of Forests. Within the extent of occurrence of fishers in the province, ~7% lies within 385 protected areas. Many of these are too small to encompass the home range of a fisher; 65 are large enough to encompass the mean home range size of a female fisher (i.e., 35 km²) and, of these, only 35 are large enough to encompass the mean home range size of a male fisher (i.e., 137 km²).

Protected areas are generally comprised of low quality habitat for fishers. There is significantly more "nil," "very low," and "low" capability habitat and significantly less "moderate," "moderately high," and "high" capability habitat inside protected areas compared to outside these areas (R.D. Weir, unpubl. data).

Results based code provisions, such as wildlife tree retention areas, coarse woody debris recommendations, old forest retention, landscape level planning, and riparian management, have the potential to address fisher habitat requirements through the retention of large trees, dense canopy closure, and abundant levels of CWD (see following section).

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

The following recommendations should be considered in areas of high management priority for fishers, such as the biogeoclimatic subzones of natural disturbance type (NDT) 3. Fisher populations in NDT3 are the highest in British Columbia because of the abundance of prey, favourable climate, and structurally complex forests with continuous overhead cover. Although the following recommendations have been developed for NDT3 (except for CWH, ICHdw, MSdk, MSdm, and SBSmc subzones) they may also be considered in other areas determined to be of high value to fishers such as the drier interior subzones of NDT2 and more northerly subzones of NDT4. These recommendations are based on the best technical information on the species at this time and some or all of them should be considered for application in localized portions of a planning area where the planning table intends to propose a conservation objective for the species.

- ❖ Fishers select resources at several spatial scales; thus it is important to consider management recommendations at all spatial scales including landscape, stand, patch, and feature. Consider the following recommendations:
- ❖ Maintain sufficient suitable habitat to support healthy populations of fishers. Areas managed for fisher should contain 30–45% mature and old forest, depending on the diversity of habitat available and prey abundance, and be suitable for fishers. Suitable habitat is characterized by shrub cover, coniferous canopy cover, sub-hygric or wetter moisture regime, patches of large, declining trees (particularly black cottonwood), and greater than average amounts of CWD for the zone.
- ❖ Maximize landscape connectivity through the use of corridors of mature and old seral forests. Ideally, connectivity should be centred on stream systems and can be achieved by maintaining large (e.g., 100 m where ecologically appropriate) riparian buffers on either side of streams (S1–S6), focusing on riparian areas that contain suitable habitat features to support fishers.
- ❖ The distribution of cutblock sizes should focus on the small and large sizes of the patch size recommendations described in the *Guide to Landscape Unit Planning*. Fishers will use small cutblocks but also require larger habitat areas. Over the long term, larger cutblocks will develop into these larger habitat areas.
- ❖ Maintain important structural attributes and natural structural complexity of forests.
- ❖ Maintain stands that provide sufficient snow interception, security, foraging, and resting cover. Silvicultural prescriptions should avoid producing stands in the herb structural stage with no CWD and strive to conserve stands with greater than average CWD and >30% closure of the coniferous canopy.

- ❖ Retain patches with a high degree of structure. Fishers use patches within otherwise unsuitable stands that provide sufficient habitat for security cover, foraging, snow interception, resting, and whelping. If it is not possible to conserve stands with the features listed above, conservation of patches within these stands should be maintained. Proposed structural variables within these retention areas include relatively high volume of CWD, large diameter (>20 cm) and elevated CWD, increased canopy and high shrub closure, and increased stocking of trees (including large diameter (>40 cm dbh) and trees containing rust brooms). If the stand that is created or otherwise altered has structural features that are less than any of the desired levels, patches with more structure should be retained.
- ❖ Retain important habitat features across the landscape.
- ❖ When using wildlife tree or old forest retention to provide denning opportunities for fishers, use Table 1 to select suitable sites.
- ❖ It is recommended that salvage does not occur in WTR areas and OGMAs established to provide habitat for this species. In addition these areas should be designed to include as many suitable wildlife trees as possible and that they should be maintained over the long-term (>80 yr).
- ❖ Ensure recruitment of suitable den sites. The availability of suitable maternal and resting den sites may be limiting factors for fisher populations.
- ❖ Maintain natural levels, decay and size characteristics as well as dispersion of CWD.

Wildlife habitat area

Goal

Maintain resting and maternal den sites.

Feature

Establish WHAs at suitable resting or maternal den sites where riparian and riparian-associated habitats contain an abundance of the specific habitat attributes described above (e.g., large declining cottonwoods), and are not included within riparian reserve zones.

Size

Generally between 2 and 60 ha but will ultimately be based on the extent of appropriate habitats.

Design

When selecting WHA boundaries, maximize the inclusion of important habitat features such as large cottonwoods and riparian habitats. Ensure suitable den sites are sufficiently buffered.

Table 1. Preferred wildlife tree retention area and old growth management area (OGMA) characteristics for fishers

Attribute	Characteristics
Size (ha)	≥2 ha
WTR location	Riparian and riparian-associated habitats
Tree features	Presence of cavities, particularly those created from broken branches and primary excavators. Large cottonwoods with cavities (>75 cm), trees with broom rust or witches broom (>40 cm dbh), and trees with heart rot and a bole diameter >54 cm at 5 m above ground.
Tree species	Cottonwood, fir, spruce, or balsam poplar
Tree size (dbh*)	>75 cm cottonwood or fir, >40 cm spruce (minimum 25 cm). Without trees with the preferred dbh, retain the largest available in the stand for recruitment.
Decay class	2 or 3 preferred, 2–6 acceptable
Structural features	Presence of large diameter (>65 cm dbh) , elevated pieces of CWD; CWD in decay classes 2–6; declining cottonwoods (>87 cm dbh)

General wildlife measures

Goals

1. Maintain mature and old cottonwood and large diameter fir and spruce along riparian and riparian-associated habitats.
2. Maintain connectivity between riparian and upland habitats.
3. Maintain important structural attributes for fishers and prey species (i.e., CWD, wildlife trees, cottonwood, and large fir and spruce).

Measures

Access

- Do not develop roads. Where there is no alternative to road development, close road during critical times and rehabilitate.

Harvesting and silviculture

- Do not harvest or salvage.

Pesticides

- Do not use pesticides.

Additional Management Considerations

Reduce incidental harvest of fishers in marten traps (i.e., specially designed traps that exclude fishers, changes to trapping timing).

Refuges have been suggested as an option for population management of fishers (Strickland 1994). Refuges are untrapped areas within fisher populations that act as source populations for trapped areas, and also as insurance against population reductions (Banci 1989). For example, persistence of fisher populations in the Omineca region has been largely attributed to untrapped traplines providing dispersing individuals into actively trapped areas (G. Watts, pers. comm.). Explicitly establishing refuges across the range of fishers in British Columbia would involve considerable co-operation among registered trapline owners and regulatory agencies (MWLAP, MOF).

Information Needs

1. Information on reproduction and trends including conception rates, litter sizes, survival to dispersal, and net recruitment to be able to better predict the ability of fishers in British Columbia to respond to changes in harvest and habitat change.
2. Threshold densities at which fishers can no long acquire sufficient resources at different spatial scales.
3. Reasons for the reuse of structures for whelping and resting remain unclear. Future effort should be directed towards continuing to assess reuse of natal dens and to determining if the availability of suitable den sites is limited across the landscape.

Cross References

Wolverine

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Grizzly Bear

Ursus arctos

Original prepared by Les Gyug, Tony Hamilton, and Matt Austin

Species Information

Taxonomy

The Grizzly Bear, *Ursus arctos*, is one of eight species of the bear family, Ursidae. There are currently two recognized North American subspecies: *U. arctos horribilis*, the common subspecies, and *U. arctos middendorffi*, the Kodiak bear, found on a few Alaskan coastal islands.

Description

Bears are different from other carnivores by their greatly enlarged molar teeth with surfaces that have lost their shearing function and are adapted to crushing, in keeping with their omnivorous diets. The forelimbs are strongly built and the feet are plantigrade and have five toes. Forefeet have long, non-retractile claws. The ears are small and the tail is extremely short.

The Grizzly Bear is the second largest member of the bear family next only to the polar bear (*U. maritimus*). Grizzlies are large, heavy-bodied bears that can attain weights of up to 500 kg (average range 270–360 kg). Exceptionally large bears have been recorded at 680 kg. Adult grizzlies reach nose-to-tail lengths of 1.8 m on average but have been recorded as long as 2.7 m. The long, outer guard hairs of the Grizzly Bear are often tipped with white, silver, or cream giving the bear a grizzled appearance. Coat colour is quite variable, usually brown but ranging from black to almost white. Coat colour is not a good characteristic for distinguishing between Grizzly Bears and Black Bears (*Ursus americanus*). Grizzly Bear facial profiles are usually "dished-in" and a hump of muscle is normally present on the shoulders. The front claws on a Grizzly Bear are longer than on Black Bears, being as long as 10 cm. The long front claws and hump of muscle on the shoulders are adaptations for digging.

Distribution

Global

The Grizzly Bear has a circumpolar distribution once covering most of North America, Europe, and the northern part of Asia. In many of these areas it has been exterminated or its numbers have been greatly reduced. Most of the world's Grizzly Bears now occur in northwestern North America and Russia.

In North America, Grizzly Bears once ranged over most of the west, from Alaska south to Mexico, and from the Pacific coast east to Manitoba, and the Missouri River (Banci 1991). In the wake of westward development and settlement, especially in the plains, the range of the grizzly shrank to its present distribution of Alaska, the Yukon Territory, and British Columbia, with small populations in Alberta, the Northwest Territories, Montana, Idaho, and Wyoming.

British Columbia

Grizzly Bears historically occurred throughout British Columbia, with the exception of some coastal islands (e.g., Vancouver Island, Queen Charlotte Islands, and others). Populations are considered extirpated from much of south and southcentral British Columbia (e.g., lower elevations of the Okanagan, the Lower Mainland, and parts of the Cariboo). However, Grizzly Bear are occasionally sighted in the southern interior plateaus and other areas from which their populations are considered effectively extirpated.

Forest regions and districts

Grizzly Bears occur in all forest regions and almost all forest districts **except** South Island, and Queen Charlotte Islands, and only in the mainland portions of the Campbell River and North Island forest districts.

Ecoprovinces and ecosections

Grizzly Bears occur in most ecoprovinces and ecosections in mainland British Columbia but are absent from Vancouver Island and Queen Charlotte Islands. The following are mainland ecosections within which Grizzly Bear populations are considered **extirpated:**

BOP: PEL, and parts of CLH, HAP, KIP

CEI: CAB, FRB, and parts of CAP, CHP, NAU, QUL

COM: NWC, and parts of EPR, SPR

GED: GEL, FRL

SOI: SOB, SOH, NOB, THB and parts of NOH, NTU, OKR, PAR, STU

Biogeoclimatic units

Grizzly Bears occur in all biogeoclimatic units except BG and CDF.

Broad ecosystem units

Grizzly Bears are wide ranging, and can occur in most broad ecosystem units.

Elevation

All elevations from sea level estuaries to high alpine meadows and talus slopes.

Life History

Diet and foraging behaviour

In British Columbia, Grizzly Bears are efficient predators and scavengers but rely more on a vegetative diet. Grizzly Bears consume a wide variety of foods, including roots and green vegetation, small and large mammals, fish, and insects. A huge variety of plant, animal, fish, and insect food sources are regionally important. Grizzly Bears are omnivorous and opportunistic in their feeding habitats. Habitat selection is governed by forage availability during the growing season. Grizzly Bear diet also changes with the seasons to make use of the most digestible foods. For example, Grizzly Bears will take advantage of palatable early spring forage. Feeding on ungulates is important during early spring, and for many bears, salmon comprises a significant fall diet item.

In general, the largest differences in the feeding patterns are between coastal and interior Grizzly Bears. On the coast (MacHutchon et al. 1993; Hamilton 1987), beginning in the spring, Grizzly Bears feed on early green vegetation such as skunk cabbage (*Lysichiton americanus*) and sedges located in the estuaries and seepage sites that become snow-free first. As the season advances, the bears follow the receding snow up the avalanche chutes feeding on emerging vegetation and roots. Ripe berries attract the grizzlies down onto the floodplain and lower slopes where they eat devil's-club (*Oplopanax horridus*), salmonberry (*Rubus spectabilis*), raspberry (*Rubus* spp.), black twinberry (*Lonicera involucrata*), elderberry (*Sambucus* spp.), and a variety of blueberries (*Vaccinium* spp.). They begin to feed on salmon (*Oncorhynchus* spp.) as they become available in the spawning channels and continue to do so until late fall, feeding on live and eventually dead salmon. Once salmon supplies dwindle, grizzlies return to feeding on skunk cabbage and other vegetation. Grizzlies will feed on insects and grubs when the opportunity arises, as well as molluscs and other animals of the intertidal zone.

In the interior (Simpson 1987; McLellan and Hovey 1995; Ciarniello et al. 2001) beginning in the spring, grizzlies feed mainly on the roots of *Hedysarum* spp., spring beauty (*Claytonia lacneolata*), and/or avalanche lily (*Erythronium grandiflorum*) depending on local abundance, and on carrion. They may also opportunistically prey on winter-weakened ungulates. As the green vegetation emerges the bears begin to graze on grasses, horsetails, rushes, and sedges. During this time, they also prey on ungulates on their calving grounds. In summer, bears follow the green-up to obtain nutritious young spring growth including locally important food sources such as cow-parsnip (*Heracleum* spp.). They also obtain early ripening fruits beginning in mid-July mainly in riparian forests and productive low elevation seral forests, such as pine-soopolallie terraces. In late-summer and fall (August–October) high elevation berries become the major food source, mainly soopolallie (*Shepherdia canadensis*), blueberries, and huckleberries. Late fall feeding focuses mainly on harder berries such as mountain ash (*Sorbus* spp.) or kinnickinnick (*Arctostaphylos uva-ursi*) that persist past the *Vaccinium* fruiting season, and on the roots of *Hedysarum* in areas where it occurs. Throughout the active season, interior grizzlies will prey on small mammals, especially ground squirrels (*Spermophilus* spp.) Fish, roots, pine nuts, or bulbs, and insects are important whenever they are available and sufficiently abundant. Army cutworm moths (Noctuidae) in high elevation alpine talus slopes and boulder fields may be locally important (White et al. 1998a).

Reproduction

Breeding occurs between the end of April and end of June. Cubs are born in the den between January and March. The average age of first reproduction for females in southeastern British Columbia is 6 years, the time period between litters is 2.7 years, and the mean number of cubs per litter is 2.3 (McLellan 1989a). In southern grizzly populations, cubs tend to stay with the mother for approximately 2.5 years. Females remain in estrus throughout the breeding season until mating occurs and do not ovulate again for at least 2 (usually 3 or 4) years after giving birth. Two offspring are generally born per litter, and young are born blind and without fur. They are weaned at 5 months of age but remain with the mother until at least their second spring (and usually until the third or fourth).

Site fidelity

Many telemetry studies have shown that Grizzly Bears are creatures of habit and will usually return to the same seasonal food sources and areas throughout their lifetimes. Foraging strategies are somewhat flexible; individuals adapt to annual variation in food supply and can learn to exploit newly available food sources. However, many of a Grizzly Bear's movements, habitat selection, and foraging patterns are learned as a cub and are reinforced throughout their lives (20–30 yr). Home range fidelity may be strong as a result, especially for females.

Home range

Home range sizes are proportionate to food quality, quantity, and distribution. Generally Grizzly Bear home ranges in productive coastal habitats near salmon stream are smaller than ranges in interior mountains, which are again smaller than ranges in interior plateau habitats. For coastal British Columbia, average minimum single year home range size was 137 km^2 for males, and 52 km^2 for females (Khutzeymateen: MacHutchon et al. 1993). For wet interior mountains, average home range size was 187 km^2 for males and 103 km^2 for females (Parsnip: Ciarniello et al. 2001; Revelstoke: Simpson 1987). For drier interior mountains or plateau areas, average home range size was 804 km^2 for males and 222 km^2 for females (Parsnip: Ciarniello et al. 2001; Flathead: McLellan 1981; Jasper: Russell et al. 1979; Kananaskis: Wielgus 1986).

Grizzly Bears, except females with cubs, and sibling groups, are solitary for most of the year except during the mating season. Mothers, daughters, and even granddaughters tend to have overlapping home ranges, while male home ranges are large and overlap with several adult females (Bunnell and McCann 1993). Habitat use and food habits studies have shown that the areas occupied by male grizzlies (200-300 km^2) are much larger than what would be required simply to obtain food. The smaller range sizes of females with young (100 km^2), which have greater energy needs than males, may provide the best estimate of the minimum feeding habitat requirements of individual bears. The large range sizes of male Grizzly Bears are probably related more to breeding than to food availability, while females may use small ranges where they can improve security of the young while still obtaining adequate food. Social intolerance and security needs of young bears probably act to distribute grizzlies widely over the available range. In many areas, adult females may inhabit marginal ranges or disturbed areas, such as road margins, where human activities exclude most larger males (McLellan and Shackleton 1988). The size of individual home ranges varies annually in response to variation in quality and abundance of food (Picton et al. 1985). Grizzly Bear habitat use is strongly influenced by intraspecific social interactions (e.g., male predation on cubs) and the presence and activities of people.

Movements and dispersal

Grizzly Bears have low dispersal capabilities relative to other carnivores (Weaver et al. 1996). This is especially true for subadult female Grizzly Bears, which usually establish their home range within or adjacent to the maternal range (e.g., McLellan and Hovey 2001). On average, male Grizzly Bears only dispersed 30 km from the ranges used as cubs with their mothers, and female Grizzly Bears only 10 km (McLellan and Hovey 2001). This inherent fidelity, particularly of female Grizzly Bears, to their maternal home ranges may reduce the rate of recolonization of areas where breeding populations have been depleted.

Habitat

Structural stage

In general terms, Grizzly Bear forage tends to be more abundant in non-forested sites, or sites with partial forest, or sites with many tree gaps in older forest. However, security habitat and day bedding areas (for heat relief, rain interception, or warmth) tend to be closed forest sites near higher quality foraging sites. Some types of forage (e.g., salmon in streams, ants in logs, ungulates) can be found within many structural stages and the forage is not necessarily tied to any particular structural stage. (Refer to Table 1 on following page.)

Important habitats and habitat elements

Denning

Denning sites are generally used from November through March and usually to mid-April in the northern areas of British Columbia. Hibernating habitats tend be high elevation areas that are sloped, and have dry, stable soil conditions that remain frozen during the winter (Bunnell and McCann 1993). Dens are usually on steep north-facing slopes, with soils suitable for digging and where vegetation will stabilize the roof of the den and snow will accumulate for insulation (Vroom et al. 1977). Wet or seepage areas and areas with shallow soils or many boulders are avoided. Bears seldom reuse an excavated den but will often come back to the same vicinity to dig their new den (Ciarniello et al. 2001).

On the coast, dens are often dug under large old trees. The tree's root mass creates a stable roof for the den. Coastal grizzlies may also use very large tree cavities much like coastal Black Bears.

Foraging

Grizzly Bears in British Columbia have such an enormous range of learned behavioural adaptations to diverse regional ecosystems that generalization about habitat requirements is difficult. Even within a region, individual bears may have vastly different approaches to meeting their requirements. Some bears, particularly males, adopt a highly mobile, seasonally "transient" strategy, whereas other bears are more "resident." Some bears rely more heavily on predation than others, and some use higher elevation annual home ranges as opposed to migrating to lower elevations on a seasonal basis.

Although meeting nutritional requirements is the primary factor in habitat choice, selection is also based on thermal cover (e.g., dens/bedding sites), security (e.g., females protecting cubs), or access to potential mates during the breeding season. Habitat selection is also strongly influenced by intra-specific (social) interactions and the presence and activities of people.

Grizzly Bear habitat requirements must be viewed at several spatial scales. Transients deliberately travel to specific landscapes in a sub-region on a seasonal basis. Both residents and transients select specific patches of habitat or complexes of habitats within landscapes. Within patches, they may only require specific food-producing microsites. Habitat requirements must also be viewed at various temporal scales; continually shifting seasonal food supplies, annual food variance (e.g., berry crop failure), and

Table 1. Forage values by structural stage

Stage	Value
1a	Forage value for army cutworm moths in alpine rockfields or intertidal marine molluscs in estuaries. Otherwise generally nil forage value except in the presence of human foods or garbage. Seasonal use of small mammals (marmots and ground squirrels).
1b	Forage value for army cutworm moths in alpine rockfields. Forage value for intertidal marine molluscs in estuaries. Otherwise generally nil forage value except in the presence of human foods or garbage.
2	Forage value can be very high on bulbs, corms, grasses, horsetails, and other herbs. These values can be found variously in wet meadows, marshes, avalanche slopes, or alpine/subalpine meadows.
3a	Forage value can be very high, particularly in recovering burned or clearcut sites where *Vaccinium* berries are abundant.
3b	Forage value can be very high, particularly in recovering burned or clearcut sites where *Vaccinium* berries are abundant. Forage value can be high in skunk cabbage swamps, which are usually a mixture of structural stages because the typical skunk cabbage swamp is often partially treed, and contains tall alder or willow shrubs as well. Similarly typical avalanche slopes are mixtures of herb, low shrub, and tall shrub stages, all of which can provide high forage values for Grizzly Bears.
4	Typical value of densely forested sites, which preclude most herb or shrub forage values, are as day bedding sites for security and heat relief in areas near other types of foraging sites. Forests that are not as densely forested may continue to support berry patches (soopolallie or *Vaccinium*) in forests beyond the open shrub stage.
5	Typical value of densely forested sites, which preclude most herb or shrub forage values, are as day bedding sites for security and heat relief in areas near other types of foraging sites. Forests that are not as densely forested may continue to support berry patches (soopolallie or *Vaccinium*) in forests beyond the open shrub stage.
6	Typical value of densely forested sites, which preclude most herb or shrub forage values, are as day bedding sites for security and heat relief in areas near other types of foraging sites. Forests that are not as densely forested may continue to support berry patches (soopolallie or *Vaccinium*) in forests beyond the open shrub stage.
7	Value of forest (beyond security and heat relief) will depend on amount of openings in forest. Forests that remain dense in stage 7 will have little value beyond that found in stages 4, 5, and 6. Forests that become patchy with numerous gaps or dying canopies may support various amounts of berries or herbs for foraging in the canopy gaps.

long-term influences on habitat quality such as fire suppression must all be considered. Concurrent attention must be given to meeting the spatial requirements of individuals within and across landscapes and examining population level habitat supply.

Conservation and Management

Status

Grizzly Bears are on the provincial *Blue List* in British Columbia. In Canada, Grizzly Bears are considered of *Special Concern* in British Columbia and *Extirpated* in part of Alberta, Saskatchewan, and Manitoba (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

The provincial population estimate from the B.C. Ministry of Water, Land and Air Protection for Grizzly Bears is estimated at a minimum of 13 800, which is ~50% of the Canadian Grizzly Bear population. Overall, the population in British Columbia currently appears stable, but local population declines have occurred in the past in many areas of the province. Grizzly Bears are considered threatened in 8% of their historic range in British Columbia and effectively extirpated in ~10% (Figure 1). Grizzly bear populations are believed to be increasing in some areas of the province.

Habitat trends

Habitat effectiveness for Grizzly Bears has decreased in British Columbia and can be expected to continue to decrease in British Columbia (MELP 1995b). Habitat effectiveness considers the habitat suitability of the area and further accounts for impacts such as habitat displacement and fragmentation that reduce the ability or willingness of Grizzly Bears to use the habitat. While some of this is due to direct loss to agriculture and settlement, increasing road access is now more important. Road access leads to direct mortality through increased human–bear conflicts, hunting, and poaching, and an avoidance of habitats near roads and areas heavily used by people for recreation, resource extraction, or other reasons.

Threats

Population threats

Historic reductions in Grizzly Bear populations were a result of extensive agricultural land conversion, extermination campaigns often related to livestock protection, and unrestricted killing (IGBC 1987). Today, the primary limiting factors for Grizzly Bears in the Canadian portion of their range appear to be human-caused mortality from a variety of factors, and habitat loss, alienation, and fragmentation (McLellan et al. 2000; Kansas 2002).

Currently, throughout the Grizzly Bear's range in North America, sources of area-concentrated mortality include hunting, poaching, and control kills associated with inadequate garbage management or other types of human-bear encounters including protection of livestock or perceived threats to human safety (IGBC 1987). In southern British Columbia,

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	AK	BC	ID	MT	YK	NWT	WA	Canada	Global
S3	S?	S3	S1	S1S2	S?	S?	S1	N3	G4T3T4

Figure 1. Status of Grizzly Bear Population Units (MWLAP). Population conservation status is based on the percentage the current population estimate represents of the capability of the habitat to support Grizzly Bears. The conservation status categories are: Viable ≥50%; Threatened <50%.

and adjacent areas of the interior mountains, people killed 77–85% of 99 radio-collared bears known or suspected to have died during 13 radio-collaring studies in a 22-year period (McLellan et al. 2000). In British Columbia where Grizzly Bear hunting was permitted, legal harvest accounted for 39–44% of the mortality. The next leading cause of grizzly mortality was killing by people in self-defence or in defence of property or livestock. Similar extensive data to estimate mortality rates is not available for northern British Columbia where fewer radio-collaring studies have been undertaken.

Increased direct Grizzly Bear mortalities are often associated with increased road access (McLellan 1990). Roads result in Grizzly Bear mortalities both directly and indirectly (as well as habitat loss; see "Habitat threats"). The mechanisms in which mortality is increased include direct mortality both through collisions on major roads, and through hunting and poaching; habituation of bears to people when they come in close contact, and the eventual loss of some of these bears involved in human-bear conflicts; and social disruption of bears with other bears when bears start avoiding habitat near newly created roads (McLellan 1990). Most of the new road building in British Columbia stems from forestry, mining, and oil and gas development. Direct human-caused mortality represents a particularly significant threat when adult females are killed in small and localized populations that may have low immigration rates.

Isolation is a significant factor in long-term (100+ yr) viability of small isolated Grizzly Bear populations such as in the Yellowstone area in the northwestern United States (Mattson and Reid 1991). The low population numbers in some areas of British Columbia are so low as to make natural recovery almost impossible given that these areas can be fairly isolated from the other Grizzly Bear population and natural immigration is likely very low. The low population numbers and isolation of localized populations such as in the North Cascades (e.g., estimate of <20; Gyug 1998) may also be creating local inbreeding that may limit any population recovery in these areas in the absence of increased Grizzly Bear immigration.

By comparison to human-caused mortality, natural mortality factors seem to be relatively minor in Grizzly Bear populations (McLellan et al. 2000). There are no known diseases or parasites that appear to have impacts on natural populations of Grizzly Bears (IGBC 1987). Predation/cannibalism, particularly of young bears by older dominant male bears, appears to play a role in population regulation, but its extent is not well known. Malnutrition is a factor in cub mortality, often within the first 1–4 weeks of emergence from the den, indicating that the nutritional state of the pregnant female entering the den is important (IGBC 1987).

Habitat threats

Habitat loss, alienation (the displacement from otherwise suitable habitat), and fragmentation (the separation of previously continuous habitat into one or more disconnected pieces) occur on a broad scale as a result of expanding human settlement, increased access for forestry and other extraction industries, and forestry and fire suppression.

Human settlement

Urban and agricultural developments are concentrated in valley bottoms formerly used as spring habitats and as movement corridors between mountain ranges. These developments cause direct habitat loss as well as habitat fragmentation by isolating major protected areas, sometimes making them inadequate to maintain viable populations. The settlement patterns along major roads or highways also tend to cause habitat fragmentation. The increasing settlement patterns along the Highway 3 corridor through the Rocky Mountains in southern British Columbia is seen as one of the major population fragmentation causes preventing extensive Grizzly Bear population recovery in the northern Rocky Mountains of the United States.

Because Grizzly Bear populations are naturally found at low densities, large areas of occupied and connected habitat are required to ensure their long term viability. To sustain habitat supply for populations, individuals must be able to move freely among valued habitats, without being restricted by human-caused blockages or being attracted to mortality sinks around human settlements. Because individuals tend to disperse very little from established populations (10–30 km; McLellan and Hovey 2001), it is necessary to maintain corridors of habitat between major protected areas that are also good habitat themselves and corridors must be "wide enough for male Grizzly Bears to live in with little risk of being killed" (McLellan and Hovey 2001).

Hydroelectric impoundments behind dams can significantly affect Grizzly Bears when lowland feeding areas, particularly important in spring, are flooded. The effect of dams, particularly on the Columbia River system, has been to stop anadromous salmon runs, which has probably significantly affected Grizzly Bear feeding opportunities over a very wide area as well.

Forest management

Before the advent of widespread fire suppression (about 1945), the primary forest disturbance regime was fire through most of the province. Currently, logging has replaced fire as the primary agent of forest succession, which can be expected to have an impact on Grizzly Bear habitat independent of any effects of increased access (Zager et al. 1983). Many post-fire habitats typically remain high productivity foraging sites (particularly for berries) for 35–70 years, and Grizzly Bears learn to rely heavily on these sites. Under current timber management and silvicultural regimes, extensive site preparation and soil disturbance by heavy machinery reduce berry productivity in clearcuts, and conifer stands are planted, managed, and tended so they close in and lose any berry foraging values within much shorter time frames than they might have had under natural wildfire regimes.

Grizzly Bears typically used forested habitats adjacent to open foraging habitats such as avalanche chutes, wet meadows, marshes and swamps, and subalpine meadows as security habitat and daytime bedding sites to avoid heat stress. Clearcutting the forests adjacent to these sites can significantly affect the suitability in these high value open sites.

Roads

Roads result in Grizzly Bear habitat alienation, (i.e., displacement from preferred habitats), as well as increased direct mortality from hunters, poachers, and management kills for bears that are not displaced (McLellan 1990; Mace et al. 1999). Vehicles on roads may harass bears, and roads tend to displace them from quality habitats (McLellan 1990). Roads also tend to result in increased human activity in areas, which increases chances for bear–human interactions that result in displacement from these habitats (as well as increases in direct mortality) (McLellan 1990).

The displacement of bears from linear habitats (i.e., roads) can also cause habitat fragmentation. In Banff National Park, the Trans-Canada Highway acts as a complete barrier to adult females, and secondary highways are only regularly crossed by female Grizzly Bears that are relatively habituated to people (Gibeau and Herrero 1998). In British Columbia, the Highway 3 corridor near Nelson/Castlegar/Trail/Salmo has been found to be a genetic barrier between southern Selkirk and central Selkirk mountain Grizzly Bear populations (Proctor 2001). Where there are still extant populations of Grizzly Bears in the northern United States, highways also cause habitat fragmentation (Servheen et al. 1998).

While the construction of access roads is not limited to forestry activities, most new roads constructed in British Columbia are to support forestry activities. The increased access allowed on even infrequently travelled roads has been shown to significantly affect habitat use by Grizzly Bears (e.g., Mace et al. 1996; Archibald et al. 1987; McLellan and Shackleton 1988). Even increases in non-motorized and non-hunting-related recreation allowed by increased access to areas can significantly affect Grizzly Bear habitat use (e.g., for mountain climbing) (White et al. 1998b). While road closures or access limitations can be implemented to reduce the effects of forest access roads on Grizzly Bears, road closures implemented in wildlife management areas on national forests in Idaho, Wyoming, Washington, and Montana were found to be relatively ineffective

(27%) at keeping all vehicles off closed roads (Havlick 1998).

Historically, conflict with ranchers and livestock grazing operations have been a major cause of Grizzly Bear population decline or local extirpation in the United States (Storer and Trevis 1978), and this impact is thought to have reduced British Columbia populations as well. Potential impacts include mortalities if ranchers shoot bears to protect livestock, competition for forage, displacement from or alteration of preferred habitats from grazing and trampling. Preferred habitats which may be impacted by grazing or trampling include wetland areas and fruit-producing areas (IGBC 1987). More information on grazing impacts on grizzly bears is provided in the IGBC (1987).

Legal Protection and Habitat Conservation

The Grizzly Bear is protected under the provincial *Wildlife Act* from unrestricted hunting. All hunting seasons on Grizzly Bears are managed through Limited Entry Hunts (LEH) open by lottery to resident hunters or by quotas granted to licensed guides. There are no LEH seasons on Grizzly Bears in any threatened Grizzly Bear Population Unit.

Within the occupied range of Grizzly Bears in British Columbia, >106 000 km^2 or 13.4% is protected. Some parks that are important for the conservation of Grizzly Bears include Khutzeymateen, Spatsizi, North and South Tweedsmuir provincial parks and Tatshenshini-Alsek National Park.

The Grizzly Bear Conservation Strategy (MELP 1995a) identified habitat as one of the key conservation needs for Grizzly Bears in British Columbia and established a framework for establishing Grizzly Bear management areas throughout the province. Habitat management would largely be achieved through strategic land use plans that would establish goals and objectives, and would set the means to attain those on publicly owned land in local areas throughout the province.

Strategic land use planning on publicly owned lands, either land use plans (LUP) or land and resource management plans (LRMP), have been completed or approved in 73% of the province by area as of January 2002. LRMP processes are underway in an additional 12% of the area or the province.

Most of the strategic land use plans that have been completed or approved to date address Grizzly Bear habitat issues (Table 2), some in more detail and length than others. In particular, LRMPs such as the Okanagan-Shuswap and Kalum have addressed Grizzly Bear habitat issues at great length and in detail, while others, such as the Kootenay-Boundary LUP, appear to have treated Grizzly Bear habitat issues only in part, and the Kamloops LRMP is silent on the issue of Grizzly Bear habitat management.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Given that Grizzly Bears have large home ranges, both the landscape and stand level requirements of Grizzly Bears should be considered during strategic or landscape level planning. Wildlife habitat areas may be established under strategic level plans to address stand level requirements, provided a timber supply budget is negotiated by the strategic level plan or under the IWMS provincial timber supply limit (see "Wildlife habitat area" below) when within a Threatened Grizzly Bear Population Unit or Grizzly Bear Management Area.

The following strategic level recommendations may be considered for translation into specific legal objectives, strategies, and general guidelines by the strategic level plan and must be clearly defined geographically at an appropriate map scale. The intent is to apply these recommendations to ensure that:

- ❖ adequate amounts of well-distributed, seasonally important habitats are available across the landscape and through time;
- ❖ these habitats can be effectively used by Grizzly Bears (i.e., areas are not unduly impacted by habitat fragmentation or displacement resulting from human activities); and
- ❖ human-caused mortality risks are minimized.

Table 2. Current approaches to Grizzly Bear habitat management within strategic land use plans in British Columbia. LRMPs are underway in the North Coast, Central Coast, Lillooet, and Sea to Sky. No LRMPs or LUPs are underway in Atlin-Taku, Dease Liard, Nass, Morice, Sunshine Coast, Merritt, or Chilliwack.

Strategic land use plan	Type of resource management zone (RMZ)	Approach to Grizzly Bear habitat management *General or specific objectives or area-based direction for Grizzly Bear habitat management*
Fort Nelson	37 area-specific RMZs	Objectives included recommendations to manage and minimize new access, to ensure industrial exploration and timber management activities are undertaken with sensitivity to Grizzly Bear habitat, and to identify and map important habitat elements incorporated into several RMZs.
Cassiar Iskut- Stikine	15 area-specific RMZs	Objectives include maintenance of large areas of high value Grizzly Bear habitat (which have been mapped) by maintaining areas of well-distributed, seasonally important habitats for Grizzly Bear across the landscape and through time. Strategies are spelled out and include managing all access to and activities in these areas, and maintaining mixes of seral stages for forage and other critical habitat features including connectivity of habitats. In addition, access management is to take into account high value Grizzly Bear habitats.
Mackenzie	72 area-apecific RMZs and RM subzones	Under general directions the objectives are to identify and manage to conserve Grizzly Bear habitat to assist in sustaining viable populations; improve the management of interactions between Grizzly Bears and humans; and manage access to maintain healthy Grizzly Bear populations. Strategies to achieve these objectives are included (i.e., developing guidelines for silviculture, timing and activities in high or spring Grizzly habitats, establishment of WHAs).
Fort St. John	24 area-specific RMZs	Objectives and strategies are given for each RMZ, and include Grizzly Bear habitat management in some RMZs where Grizzly Bear management was a priority. For example, in one RMZ, an objective to "Maintain medium and high quality Grizzly Bear habitat" has strategies specified to identify and map the habitat; incorporate habitat protection criteria into landscape and stand level plans; plan and develop access to avoid habitats; incorporate habitats and connectivity corridors into landscape level plans; use WHAs, develop interagency plans where there is the potential for activities to negatively affect habitat; encourage the use of silvicultural systems that minimize negative impacts on habitat; and minimize impacts by ensuring that critical habitat areas are linked by connectivity corridors.
Dawson Creek	12 area-specific RMZs	Specific directions have been left to lower level planning initiatives. Several RMZs contain the following objective: "Manage medium and/or high capability Grizzly Bear habitat to assist in sustaining viable, healthy Grizzly Bear populations" using the strategy of identifying and mapping medium and high capability Grizzly Bear habitat, and incorporating into landscape unit level and operational planning."

Strategic land use plan	Type of resource management zone (RMZ)	Approach to Grizzly Bear habitat management ***General or specific objectives or area-based direction for Grizzly Bear habitat management***
Fort St. James	36 area-specific RMZs	Two objectives in general directions are to maintain or enhance Grizzly Bear habitat and populations, and to minimize conflicts in human–bear interactions. The strategies to achieve the first objective include completing Grizzly Bear habitat mapping in areas of concern; managing for a mosaic of habitat types and characteristics to ensure adequate seasonal foraging sites with adjacent cover; reducing habitat fragmentation by providing FENs or movement corridors; and in high Grizzly Bear habitat suitability areas, undertaking access management planning, establishing management zones around important and valuable habitats, timing development to minimize conflicts, minimizing Grizzly Bear displacement from preferred habitats, creating irregular edges and leaving cover within cutblocks and between cutblocks and roads, and locating roads to avoid valuable Grizzly Bear habitat.
Kispiox	18 area-specific RMZs (not including Protected Areas)	Extensive Grizzly Bear habitat management strategies are included in the general management directions, rather than in area-specific RMZs. Listed strategies include identifying and mapping high value habitat at the landscape planning level that will be protected through management strategies such as buffering with reserves, modifying silvicultural systems, and minimizing clearcut sizes; selection harvesting a minimum of 5% of the forested portion of high value Grizzly Bear habitat outside RMAs or WHAs; using established strategies for management of Grizzly Bear habitat in the development and review of landscape and operational plans, designation of Grizzly Bear management areas, co-ordinated access management plans and modified road construction; and restricting Grizzly Bear hunting in portions of the planning area as part of the provincial conservation strategy.
Kalum	Generic land use class RMZs	Grizzly Bear habitat importance, and objectives and strategies for management are extensively laid out at more length and with more specifics than in any other LRMP. Intent of these objectives and strategies was to maintain or restore Grizzly Bear habitats through access management and forage supply for identified watersheds; conserve, mitigate, or restore critical patch habitats at the stand level no matter where they occur; maintain current Grizzly Bear population density, distribution, and genetic diversity in each GBPU to ensure viability; and recover local Grizzly Bear population where appropriate. The Special RMZ class was divided into 9 types, one of which is "Grizzly Bear benchmark and linkages." Three Special Grizzly Bear RMZs were created as benchmark or linkage habitats where no hunting is allowed, in addition to the general management directions.
Bulkley	Generic land use RMZs, with	12 Planning Units overlaid on RMZs Specific directions for Grizzly Bear management are given in each of 12 Planning Units (or for subunits). Directions are relatively generic, e.g., "Maintain goat and Grizzly Bear habitat. Prescriptions will focus on the importance of maintaining Grizzly Bear habitat, especially that required for travel and denning," or "Complete Grizzly Bear interpreted ecosystem mapping and incorporate into management prescriptions as directed by the Babine Local Resource Use Plan (LRUP). Actual management of habitats defaults to lower level plans (LRUP or IWMS).

Strategic land use plan	Type of resource management zone (RMZ)	Approach to Grizzly Bear habitat management *General or specific objectives or area-based direction for Grizzly Bear habitat management*
Lakes	Established generic land use RMZs	General management direction objectives are to "maintain the diversity and a suitable abundance of wide ranging carnivore populations and the ecosystems upon which they depend." Strategies to implement this for Grizzly Bears include upgrading capability/suitability mapping, establishing Grizzly Bear management plans and management areas in accordance with the provincial Grizzly Bear conservation strategy, and implementing Grizzly Bear management guidelines in areas of important habitat capability and known occurrence of Grizzly Bear.
Vanderhoof	20 area-specific RMZs	Under general management directions, the objective is to maintain or enhance Grizzly Bear populations and habitat by identifying and mapping of high suitability and capability Grizzly Bear habitat, by deactivating non-essential secondary roads and minimizing the amount and duration of new road access in high value habitats, and by managing for a mosaic of habitat types and characteristics.Further strategies for Grizzly Bear habitat management are made in some RMZs but are fairly generic, referring to inventory of habitats, maintenance of habitats, and "establishment of appropriate management plans."
Prince George	54 area-specific RMZs	Addressed in each area-specific RMZ. For example, within RMZ#1, the Parsnip High Elevation RMZ in the Special Resource Management Category-Natural Habitat, the objective is to "manage Grizzly Bear habitat to provide opportunity for population levels to increase" by identifying areas of high suitability and critical habitat where there will be access management planning with the intent of deactivating non-essential roads and minimizing the amount and duration of new roaded access, where the use of sheep in vegetation management will be avoided, where a mosaic of habitat types and characteristics and stand attributes that mimic habitat most suitable for Grizzly Bears, and where disturbance will be avoided to known Grizzly Bear denning sites.
Robson Valley	23 area-specific RMZs	General objective is to "maintain or enhance habitat and/or increase numbers, genetic variability, and distribution" through 9 strategies including identifying, conserving, and managing critical habitat in medium and historically high density bear zones, encouraging land use practices that promote the long-term viability of important forage species, managing road access, establishing Grizzly Bear management areas or other land use designations that benefit Grizzly Bear populations, ensuring the continued existence of adequate seasonal foraging sites with adjacent cover, minimizing bear displacement from preferred habitat by preventing habitat fragmentation, locating roads to avoid avalanche paths, leaving forest reserves of 100 m on each side of important avalanche paths, and timing human activities to avoid conflicts with concentrated seasonal bear use areas. Within individual RMZs, the above objective is repeated for wildlife with area-specific strategies on access and on reducing conflicts between Grizzly Bears and commercial recreation use, mining development, and range use.

Strategic land use plan	Type of resource management zone (RMZ)	Approach to Grizzly Bear habitat management ***General or specific objectives or area-based direction for Grizzly Bear habitat management***
Kamloops	6 land use classes with smaller RMZs	Not addressed.
Okanagan-Shuswap	Resource-Use Specific RMZs which overlap with other RMZs	RMZs established for Grizzly Bear habitat management, which overlap with RMZs for other species or other land uses. The Grizzly Bear RMZ establishes (in much more detail than most other LRMPs) the locations of areas managed as Grizzly Bear habitat; and provisions for maintaining screening, security, and thermal cover adjacent to critical habitats. It also establishes how to maintain or enhance forage availability, cover, and connectivity; how to minimize negative interactions associated with access; and how to minimize negative interactions associated with commercial tourism and recreation developments.
Kootenay-Boundary LUP	RMZs are equivalent to forest districts	Addresses land use classes within RMZs by mapping Biodiversity Emphasis Zones, Connectivity Corridors, Enhanced RD Zones (Timber), Caribou Habitat Areas, and Areas managed for mature. The KBLUP-Implementation Strategy has only one objective relating to Grizzly Bear habitat: "To maintain Grizzly Bear habitat, retain adequate amounts of mature, and/or old forests, as determined through Objective 2, adjacent to important avalanche tracks."
Cariboo-Chilcotin LUP	3 resource development zones (RDZ)	Each RDZ is subdivided into areas for which the following clause, or a very close approximation, is included as resource targets: "To manage for Grizzly Bear, moose, furbearer, species at risk, and other sensitive habitats within the areas identified as riparian buffers, recreation areas, caribou habitat, and lakeshore management zones and throughout the polygon under the biodiversity conservation strategy."

Access

Where planning tables propose a conservation objective for Grizzly Bears, they should consider application of a variety of access management measures designed to ensure habitat security, prevent population fragmentation, minimize displacement from preferred habitat, and minimize mortality risk. Access management regimes should be applied over areas roughly equivalent to an average adult female home range, and the practices directed at ensuring adult female security and survival. Access management may include complete closure of roads, seasonal closure of roads, limiting access to commercial or industrial users only, or other access regimes designed to prevent displacement of Grizzly Bears from areas near roads.

Objectives should include provisions that maximize the net amount, quality, and seasonal representation of Grizzly Bear habitat that is >500 m from an open road (i.e., roads that receive any motorized use from 1 April to 31 October). Larger roadless areas (e.g., >1000 ha) are preferred. Wherever possible, retain these areas for at least 10 years. Similarly, objectives should include minimizing the amount of areas with >0.6 km/km^2 of open road (i.e., a road without restriction on motorized vehicle use) where these are in Grizzly Bear habitat. Consider also the following provisions:

- ❖ Promote one-side development (i.e., road construction and harvesting on one side of a valley at a time).
- ❖ Remove ballast from roads across avalanche chutes. Close permanent roads by removing bridges. Remove bridges when permanently deactivating roads. Revegetate temporary access (e.g., excavated or bladed trails), roads, and landings with non-forage species to minimize mortality risk of attracted bears.
- ❖ Minimize the impact of open roads on Grizzly Bears.
- ❖ Schedule forestry activities to avoid displacing bears from preferred habitat during periods of seasonal use.
- ❖ Provide windfirm visual screening along roads to provide security (i.e., do not conduct vegetation management or stand tending adjacent to roads).

Seral stage distribution

- ❖ Maintain or restore Grizzly Bear foraging opportunities and habitat effectiveness across the landscape and over time.
- ❖ Determine current and future forage values and habitat effectiveness of planning area. Landscapes with extensive areas of mid-seral forest characterized by closed canopies, conifer dominance, and high stocking levels have little Grizzly Bear habitat value. Similarly, suitable foraging habitat may not be effective (i.e., useable) because of the proximity to human settlement, transportation routes, agriculture, or other human activities or development. Current forage values and habitat effectiveness at the landscape level can be determined through interpretations of ecosystem maps (e.g., TEM, PEM, BEI) or other surrogate maps using the 6-class wildlife habitat mapping system (RIC 1999). Interpretations should assess habitat effectiveness that may be reduced in areas near human settlement or developments, agricultural areas, and roads. In addition, the type of disturbance that has created early seral habitats, and likely outcome of the type of disturbance should be assessed. For instance, logging and wildfire both produce early seral habitats that may be mapped similarly by ecosystem mapping, but can be very different in the amount of foraging potential for Grizzly Bears, and in the length of time this foraging potential will be available to Grizzly Bears.
- ❖ Where developments reduce the effectiveness of habitat within a landscape, where forest succession is reducing foraging values, or where restoration is an objective, consider management of early seral stages to recover effectiveness lost to development or to forest succession. Foraging habitat can be created by creating early seral habitats, but only if managed effectively for Grizzly Bear forage, and remain useable by Grizzly Bears.
- ❖ Manage landscapes for steady levels of early seral habitat to avoid “booming” and “busting” forage supply.

Silviculture

- ❖ Lower conifer stocking levels to provide Grizzly Bear forage.

- ❖ In NDTs 1–3, retain 50% of the largest pieces (top 20% diameter and length) of coarse woody debris in decay classes 1–2 for summer foraging on ants.
- ❖ Do not use broadcast vegetation management methods in capable watersheds, except where stand establishment or re-establishment is the objective and broadcast methods are required. Vegetation management methods, listed in increasing order of impact on Grizzly Bear forage are manual, chemical, cover crops, and sheep grazing.
- ❖ Do not use sheep, domestic goats, or cattle for vegetation management in occupied Grizzly Bear habitat to reduce direct and indirect conflicts with bears.

Range

- ❖ Consider establishing zones where range permits will be gradually removed and no new permits issued to reduce direct and indirect conflicts with Grizzly Bears. Use the effectiveness classes (based on BEI or finer-scale mapping interpreted for Grizzly Bear seasonal habitats with the application of habitat effectiveness from roads and human settlement) to decide where to limit grazing.

Restoration

- ❖ Conduct controlled burning to improve berry production (e.g., in ESSF).
- ❖ Plan for extended rotations to recover mature and old-growth characteristics such as more open canopies, greater amounts of understorey forage, and/or large trees (e.g., for rain interception in bedding habitat on coastal floodplains).
- ❖ Implement thinning and/or pruning to maintain open stands.
- ❖ Commercially thin to reopen closed canopies and recover productive shrub understories. Consider uneven spacing to maximize forage benefit.

Preventing human–bear conflict

- ❖ Maintain "attractant"-free main and fly-in camps (e.g., camps for tree planters, cruisers, engineers). Ensure adequate food storage and garbage management.

Wildlife habitat area

Goals

Protect known areas of concentrated seasonal use by Grizzly Bears.

Maintain the ecological integrity of important seasonal habitats.

Ensure the security of the bears using these habitats.

Feature

Establish WHAs for provincially significant areas, or for seasonally important habitats used by Grizzly Bears on a more local basis. Areas that are of provincial significance are those areas of known, consistently high, seasonal congregations of Grizzly Bears. Areas of seasonally important habitats may include salmon spawning areas where Grizzly Bears feed, herb-dominated avalanche tracks and run-out zones on southerly and westerly aspects, and known denning areas. On the coast, important seasonal habitats may also include estuaries, skunk cabbage swamps, and non-forested fen/marsh complexes. In the interior, seasonally important units may include herbaceous riparian meadow/wetland complexes, post-fire stands dominated by *Vaccinium* spp., subalpine parkland meadows, and *Hedysarum* and glacier lily complexes. Seasonally important habitats will be evaluated by Grizzly Bear Population Unit or subpopulation unit. In general, the subpopulation units are equivalent in size to landscape units.

In the absence of higher level plan direction, WHAs established within the provincial IWMS timber supply impact limit will only be established within threatened Grizzly Bear Population Units and Grizzly Bear Management Areas designated under the *Wildlife Act*, except for sites where there is no timber supply impact or the site is considered provincially significant (i.e., areas of known, consistently high, seasonal congregations) and recommended by the Director of the Biodiversity Branch, B.C. Ministry of Water, Land and Air Protection.

Size

WHAs will range from 1 to 500 ha but will ultimately depend on area of use, extent of seasonal habitat, and buffer size required to meet goals and objectives.

Design

When the main objective is to minimize disturbance around seasonal concentrations, consider the use of the area by Grizzly Bears and ensure the WHA includes a sufficient management zone to prevent disturbance. When the main objective of the WHA is to maintain seasonally important habitats, the WHA will be based on the extent of the seasonal habitat plus ~50 m but may vary with patch characteristics and objectives.

Use 6-class seasonal Grizzly Bear habitat capability and suitability mapping, where available, to identify seasonally important habitats (see RIC 1999). This assessment should be based on applying the Grizzly Bear densities associated with each capability class at the landscape scale (see Table 3). The result will be an estimate of the number of Grizzly Bears the area could potentially support in each season based on habitat suitability and capability. The season or seasons that would potentially support the lowest number of Grizzly Bears may be limiting or restricting the ability of the area to support Grizzly Bears. The highest suitability habitats within this limiting season(s) should then be considered priorities for protection through the establishment of WHAs depending on how restrictive the habitat "bottleneck" (i.e., limiting) may be and the habitat effectiveness of sites. Consideration should also be given to seasonal habitat effectiveness (e.g., an area may not be limited by the availability of suitable spring habitat; however, human activities disproportionately impact these habitats the area may be limited by the availability of effective spring habitat).

Otherwise use air photos, forest cover mapping, and any other appropriate sources of information combined with expert knowledge of Grizzly Bear habitat values and human impacts to qualitatively approximate the process described above.

General wildlife measures

Goals

1. Maintain ecological integrity of WHA.
2. Ensure security of Grizzly Bears within WHA by minimizing disturbance to bears within WHA.
3. Maintain Grizzly Bear forage values within WHA.
4. Minimize human-bear interactions.
5. Maintain windfirmness.

Table 3. Habitat capability and suitability classes and associated densities for Grizzly Bears*

Habitat capability or suitability class	Habitat capability or suitability range as % of provincial benchmark density	Grizzly Bear population density	
		Minimum bears/ 1000 km^2	Maximum bears/ 1000 km^2
1 – Very High	76–100	76	100
2 – High	51–75	51	75
3 – Medium	26–50	26	50
4 – Low	6–25	6	25
5 – Very Low	1–5	1	5
6 – Nil	0	0	1

* These densities are suitable to use with 1:250,000+ scale mapping; relative densities should be applied to more detailed mapping.

Measures

Access

- Do not construct roads, trails, or landings.

Harvesting and silviculture

- No forestry practices should be carried out with the exception of treatments approved by the statutory decision maker to restore or enhance degraded habitat or to ensure windfirmness.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to maintain forage value for Grizzly Bears and minimize the potential for conflicts.
- Do not place livestock attractants within WHA.
- Incorporate management strategies in the range use plan to reduce contact and competition between livestock and Grizzly Bears. Consider salt placement, alternate water development, drift fencing, or altering periods of livestock use.

Additional Management Considerations

Ensure that Grizzly Bears do not have access to unnatural food sources (garbage) because of the consequent mortality risk.

Development around security and foraging WHAs should be managed to prevent disruption of natural influences of above- and below-surface drainage, shade, wind, and snow movement within the WHA.

Maintain livestock health.

Do not turn livestock out onto WHAs for Grizzly Bears during calving or lambing times.

Information Needs

1. Further development and application of techniques to monitor Grizzly Bear population and habitat trends.
2. Additional research on effects of human activities on Grizzly Bear habitat use (i.e., temporal response to access management).
3. Further development of techniques for assessing the impacts of proposed developments and land uses and for setting strategic objectives for Grizzly Bear habitat conditions.

Cross References

Bull Trout, Marbled Murrelet

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Wolverine

Gulo gulo

Original[1] prepared by R.D. Weir

Species Information

Taxonomy

Wolverines (*Gulo gulo*) are members of the family Mustelidae (subfamily Mustelinae) in order Carnivora. Wolverines are currently considered one species throughout their circumpolar range (Kurten and Rausch 1959), although two subspecies are recognized: *G. gulo luscus* (North America), and *G. gulo gulo* (Eurasia). Banci (1982) determined that there were insufficient differences in cranial morphology to consider the Vancouver Island wolverine as a subspecies distinct from mainland wolverines in British Columbia. Although they are the sole members of their genus, wolverines are most closely related to members of the genus *Martes* (e.g., American Marten, Fisher; Dragoo and Honeycutt 1997).

Description

Wolverines are the largest terrestrial members of the weasel family. Wolverines are sexually dimorphic, with the body mass of males ranging from 12 to 18 kg and females ranging from 8 to 12 kg (Hash 1987). Wolverines have stout bodies ranging from 65 to 105 cm in length with moderately bushy tails 17–26 cm in length (Hash 1987). Wolverines are most easily identified by their pelage that is dark chocolate brown over most of the body with lighter-coloured hair around the forehead and along a lateral stripe extending from the ears or shoulder to the sacral region.

Distribution

Global

Wolverines are holarctic in their distribution, generally occurring between 45° and 70° latitude in North America and 50° and 70° latitude in Eurasia (Wilson 1982). Wolverines occur in the tundra, taiga plains, and boreal forests of North America, Europe, and Russia, and in many of the montane habitats of the western Cordillera of North America.

British Columbia

Wolverines are widely distributed, albeit at low densities, throughout much of British Columbia. Wolverine populations do not occur on the Queen Charlotte Islands and may be extirpated from Vancouver Island, the lower Fraser Valley, the Okanagan Basin, and the Thompson Basin.

Forest region and districts

Wolverines likely occur in portions of each forest region, except for the Queen Charlotte Islands, South Island forest districts, and possibly other districts on Vancouver Island (e.g., North Island and Campbell River).

Ecoprovinces and ecosections

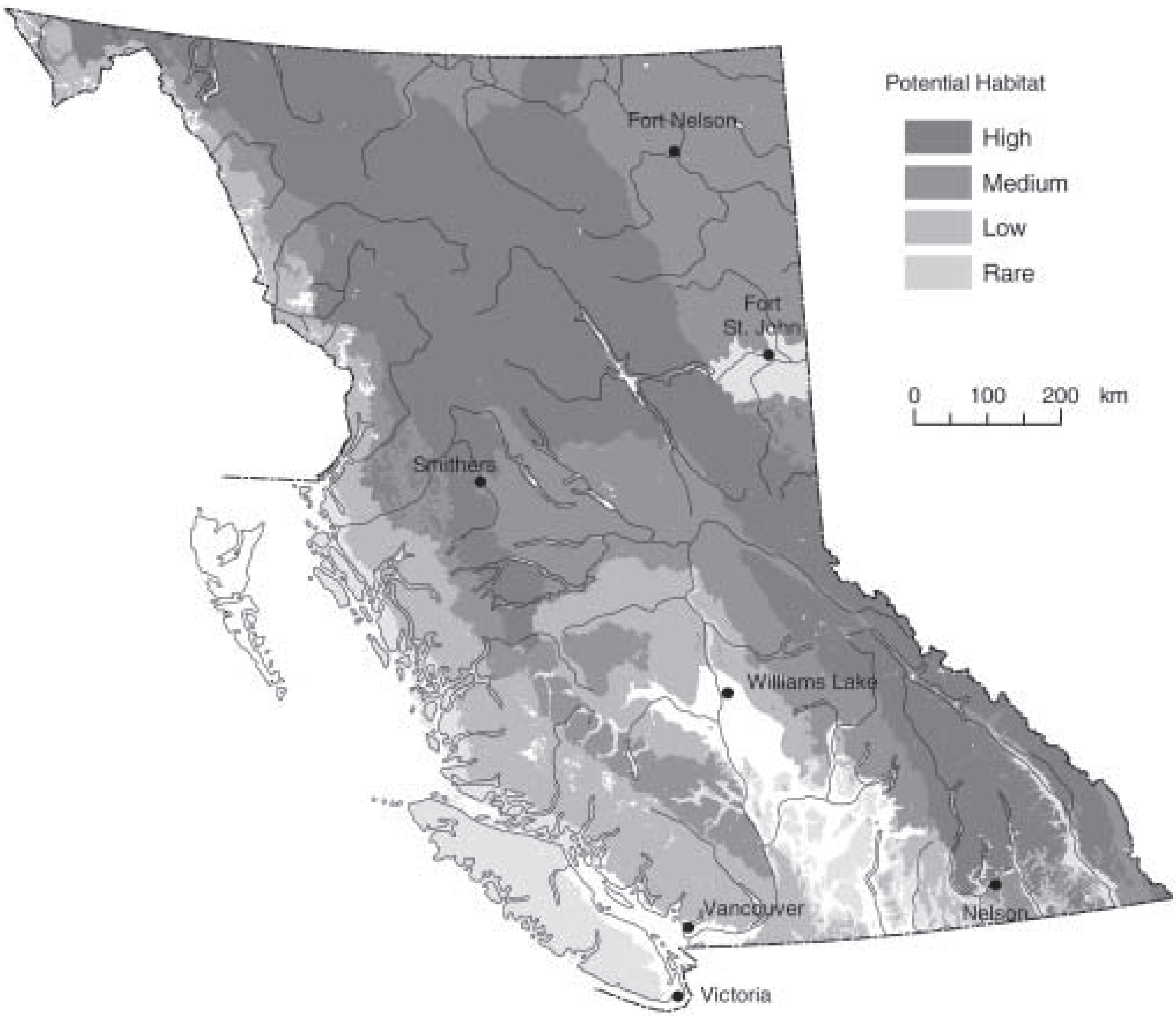
Wolverines occur in all terrestrial ecoprovinces, except for the Georgia Depression Ecoprovince.

Biogeoclimatic units

Wolverines can occur in all biogeoclimatic zones, except for BGxh, BGxw, CDFmm, CWHwh, IDFxh, IDFxm, IDFxw (and all grassland phases in the IDF), PPdh, and PPxh subzones.

1 Draft account for Volume 1 prepared by E. Lofroth.

Wolverine
(Gulo gulo)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Biogeoclimatic zones and subzones with the capability to support wolverines

AT: p
BWBS: dk, mw, unr, vk, wk
CWH: dm, ds, mm, ms, unc, vh, vm, wm, ws, xm
ESSF: dc, dcp, dk, dkp, dv, dvp, mc, mk, mm, mv, mw,,mwp, ung, vc, vcp, wc, wcp, wk, wm, wv, xc, xcp, xv
ICH: dk, dw, mc, mk, mm, mw, vc, vk, wc, wk, xw
IDF: dk, dm, dw, mw, unk, unn, unv, ww
MH: mm, unr, wh
MS: dc, dk, dm, dv, unk, unv, xk, xv
PP: dh
SBPS: dc, mc, mk, xc
SBS: dh, dk, dw, mc, mh, mk, mm, mw, unk, unr, vk, wk
SWB: dk, mk, unr, vk

Note that wolverines may not currently occur in each of the subzones listed.

Broad ecosystem units

Wolverines likely use a wide variety of broad ecosystem units (BEUs). The following BEUs may be used by wolverines; however, the intensity and frequency of use is likely highly variable and linked to the ability of the habitat to support specific food sources (e.g., moose, caribou, hoary marmots). Each unit has been assigned a rank to denote its relative importance to wolverine ecology (1 = high, 2 = medium, 3 = low, 4 = very low) (Lofroth 2001, J.A. Krebs, pers. comm.). There is very limited data for the coastal habitats.

Unit	Likely Importance	Unit	Likely Importance
AD	4	LP	2?
AG	1	ME	4
AH	1	MF	3
AM	1	MR	4
AN	3	MS	3
AS	2	PB	4
AT	1	PR	1
AV	1	RB	3
BA	2	RD	3
BB	4	RR	1
BG	4	RS	3
BK	2	SA	2
BL	3	SB	3
BP	3	SC	3
CG	3	SD	3
CH	3	SF	2
CP	4	SG	2
CR	1	SH	3
CS	2	SK	2
CW	3	SL	3
DF	4	SM	1
DL	4	SR	2
EF	2?	SU	2
ER	1	SW	2
ES	3	TA	1
EW	2?	TB	2?
FB	3	TF	4?
FE	4	WB	2
FP	1	WG	4
FR	3	WL	3
HB	3	WM	3
HL	4	WP	2
HP	2	WR	1
HS	3	YB	4
IG	2	YM	3
IH	2	YS	4?
IS	2?		

Elevation

Wolverines range from valley bottoms to alpine meadows. The upper limit of their elevational range is likely limited by the distribution of prey at higher altitudes (J.A. Krebs, pers. comm.). In areas with mountainous terrain, there appears to be some segregation in use of different elevations among sex and age classes (Whitman et al. 1986, Lofroth 2001); adult females typically occur at higher elevations than other sex and age classes, followed by subadult females, then adult males (Lofroth 2001). Subadult males typically occur at the lowest elevations.

Life History

Diet and foraging behaviour

Wolverines consume a variety of food items, but large ungulates (e.g., moose [*Alces alces*], elk [*Cervus elaphus*], caribou [*Rangifer tarandus*], deer [*Odocoileus* spp.], and mountain goats [*Oreamnos americanus*]), primarily obtained as carrion, form a large component of their diet (Hash 1987). Wolverines are also reported to eat snowshoe hares (*Lepus americanus*), porcupines (*Erethizon dorsatum*), sciurids (including marmots), mice and voles, birds, fish, and vegetation (Banci 1994).

Composition of the diet appears to vary seasonally and with the sex of the individual. In the Omineca region, moose are consumed throughout the year by all age and sex classes (Lofroth 2001). However, during summer, adult females with kits included hoary marmots (*Marmota caligata*) as a substantial portion of their diet. Banci (1987) speculated that small mammals become more important as a prey item as the availability of large ungulate carrion diminishes.

The reliance upon particular species for food likely varies regionally with availability of the species. In the Omineca region, wolverines consume moose throughout the year (Lofroth 2001). In the north Columbia Mountains, wolverines consume caribou, mountain goats, and moose most frequently (J.A. Krebs, pers. comm.). In areas with anadromous salmon runs, fish may be an important supply of food for wolverines (Banci 1987).

Female wolverines are faced with an energy bottleneck while using natal and maternal dens. Their dens appear to have specific structural requirements (see "Habitat," below), but they must also be relatively close to a reliable source of food. In both the Omineca region and northern Columbia Mountains, female wolverines situate their natal and maternal dens in areas bordering the ESSF/ESSFp ecotone in early April. The timing of this process concurs with the movement of caribou to high-elevation areas in late winter. The prevalence of caribou remains in scats collected at natal dens suggests that female wolverines rely heavily upon caribou as a predictable food source during this period (Lofroth 2001). Krebs and Lewis (2000) speculated that kit production and survival might be strongly linked to carrion supply.

Researchers have long assumed that wolverines primarily scavenge for food. Wolverines are well-known for their ability to detect animal remains buried under several feet of snow and are also reported to cache food that they have scavenged and revisit these sites later in the year (Hash 1987). It is speculated that wolverines obtain about 60% of their food intake through carrion (E. Lofroth, pers. comm.). However, in the Omineca region and Columbia Mountains, researchers have observed wolverines attacking and killing caribou (Lofroth 2001). In the rugged and snowy northern Columbia Mountains, wolverines appear to rely heavily upon avalanche-killed ungulates (e.g., caribou, mountain goats, moose) during winter and may be less reliant on wolf predation as a source of carrion than in other areas (J.A. Krebs, pers. comm.). Wolverines appear to actively hunt smaller prey during non-winter periods and rely less upon carrion (E. Lofroth, J.A. Krebs, pers. comm.).

Wolverines search widely for food. Daily movements for wolverines can be up to 65 km (Wilson 1982). Female wolverines regularly move 20 km a day even while maintaining a natal den (E. Lofroth, pers. comm.). It is unknown if they use any specific habitats preferentially for foraging, although the activity rates of wolverines within late successional and riparian forest indicate that this may be a heavily used habitat while foraging or searching for prey or carrion (Lofroth 2001).

Reproduction

Wolverines breed between late April and early September but embryos do not implant until January. Sometime between late February and mid-April, females give birth to between one and five cubs. They nurse for 8–9 weeks after which they leave the den but stay with mother for their first winter learning to hunt. Young disperse in spring. Natal dens are often underground.

Site fidelity

Wolverines are not widely reported to exhibit strong site fidelity, except for females with natal or maternal dens. While rearing kits, females will use a natal den for approximately 20–60 days and between one and four maternal dens for 5–20 days each (Magoun and Copeland 1998; Lofroth 2001). These dens are not likely reused between years.

Home range

Only adult wolverines maintain distinct home ranges. Wolverines have mildly intrasexually exclusive home ranges, where males will overlap with one or more females and other males, but females will not overlap their home ranges with other females (Krebs and Lewis 2000). Male home ranges are typically three times the size of those of females (Omineca, males: 1366 km^2, females: 405 km^2 [Lofroth 2001]; northern Columbia Mountains, males: 1005 km^2, females: 311 km^2 [Krebs and Lewis 2000]). Home ranges are maintained between years.

Movements and dispersal

Daily movements of wolverines are likely mediated most strongly by the availability and distribution of food throughout the year, although wolverines do spend substantial time moving through mature and old forest structural stages (E. Lofroth, pers. comm.). Wolverines in the northern Columbia Mountains seem to prefer moving about the landscape by following watercourses and using low elevation passes between valleys (J.A. Krebs, pers. comm.).

However, human-caused features can have a substantial effect on the ability of wolverines to move successfully throughout the landscape. Human activity (e.g., log hauling, logging, mining) may displace or alter movement paths of wolverines in highly modified landscapes (Lofroth 2001) and wolverines will often avoid entering young (<25 years) cutblocks while travelling (J.A. Krebs, pers. comm.). Transportation corridors can interrupt or alter daily movements (Austin et al. 2000) and can be a source of mortality within the population (Krebs and Lewis 2000). Man-made reservoirs may alter the dispersal routes of wolverines in the landscape (E. Lofroth, J.A. Krebs, pers. comm.). Kyle and Strobeck (2001) speculated that habitat loss, overharvest, major transportation corridors, and other anthropogenic factors limit successful dispersal among metapopulations. The viability of populations of wolverines in southern portions of the range may depend upon large areas of undisturbed habitat with corridors connecting them.

Subadult female wolverines typically disperse short distances away from their natal home ranges and males disperse 30–100 km (Magoun 1985), although dispersals of up to 378 km have been documented (Gardner et al. 1986). Subadult wolverines are slightly nomadic and travel widely prior to establishment of a permanent home range. Movements by subadults are characterized by periods of concentrated use of a relatively small area, interspersed by large-scale movements (Lofroth 2001). Subadults typically establish a home range by the time they reach 24 months. Habitat composition likely plays a relatively small role in dispersal; however, extensively clearcut watersheds would likely be avoided while transient (J.A. Krebs, pers. comm.).

Habitat

Structural stage

Wolverines, being dependent upon a variety of different food items throughout the year, use a wide assortment of structural stages in their day-to-day life, although mature and old forest structural stages are used predominately. In the Omineca region of north-central British Columbia, Lofroth (2001) reported that at least 50% of the locations of radio-tagged wolverines were in late successional stands (structural stages 6 and 7) and wolverines had relatively little use of mid-successional stands (stages 3 and 4). He also noted that the use of structural stages by wolverines varied among sexes and seasons; females tended to use both early-successional (stages 1 and 2) and late-successional stands (stages 6 and 7), while males used mostly late-successional stands. Most of the use of early-successional stands by females occurs in the use of high elevation habitats during the rearing season, when they are provisioning for young. In the northern Columbia

Mountains, wolverines tend to use late-successional stands (stages 6 and 7) most frequently when they are not using alpine habitats. Wolverines in this area may use late-successional forests because they confer some thermal and security cover benefits (J.A. Krebs, pers. comm.). To date, neither of these studies has completed their respective habitat selectivity analyses, so these results are preliminary estimates of use, not selectivity.

At a landscape spatial scale, wolverines tend to have some broad patterns of use. In mountainous areas of British Columbia, females tend to use ESSF biogeoclimatic zones during winter and AT zones during the summer. Males, on the other hand, tend to use lower elevation zones during winter and switch to ESSF zones during the summer (Krebs and Lewis 2000, Lofroth 2001). Wolverine populations tend to occur in areas where a diversity of abundant seasonal food is available within home ranges, which is often related to elevational diversity.

Important habitats and habitat features

"Habitat" for wolverines is not easily delineated as a set of vegetative parameters, such as those that are typically used to identify and classify terrestrial ecosystems, but is likely defined by the distribution and abundance of food, including carrion as well as suitable habitat/structures for denning and rendezvous points (i.e., sheltered places where kits are left during foraging periods). Most studies of wolverine habitat use show little, if any, selection for habitat at the stand scale (e.g., Whitman et al. 1986; Banci and Harestad 1990). This is likely because wolverines are not small-scale habitat specialists but rather require a suite of habitat variables that occur at larger spatial scales (e.g., landscapes, regions).

Thus, wolverines do not have easily defined habitats or small-scale habitat features for which they select. For lactating females and their young, an arrangement of habitats that provide a suitable supply of large ungulate carrion during the late winter in close juxtaposition to an area that supplies adequate food during summer (e.g., marmots) and suitable shelter is important (Krebs and Lewis 2000).

Natal and maternal dens are probably the only small-scale structures for which wolverines exhibit selection. Female wolverines typically situate dens in snow tunnels leading to masses of fallen trees (accumulations of classes 1–3 coarse woody debris [CWD]) or rocky colluvium (Magoun and Copeland 1998; Krebs and Lewis 2000; Lofroth 2001). The CWD associated with natal and maternal dens is likely formed through a variety of processes, such as windfall, avalanches, and insect-induced mortality. Natal and maternal dens are generally associated with small-scale forest openings (e.g., <100 m across) at high-elevations (i.e., ESSF/ESSFp ecotone; Krebs and Lewis 2000; Lofroth 2001). The composition and placement of dens within the landscape is important because these structures provide security for kits (i.e., snow cover) with proximity to food resources (i.e., late-winter carrion or prey).

Conservation and Management

Status

The Vancouver Island Wolverine is on the provincial *Red List* in British Columbia; whereas the mainland subspecies is on the provincial *Blue List*. The eastern Canadian population in the Ungava Peninsula and Labrador is designated *Endangered* (COSEWIC 2002). The western Canadian (YT, NT, NU, BC, AB, SK, MB, ON) population of wolverines is considered to be of *Special Concern* (COSEWIC 2002). Wolverine populations in Eurasia are believed to be at a low density, but stable (Hash 1987).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

Population	BC	ID	MT	Canada	Global
Vancouver Island	S1	–	–	N1	G4T1Q
Mainland BC	S3	S2	S2	N4	G4T4

Trends

Population trends

Very little is known about the size of the population of wolverines in British Columbia and no current estimate of the population size exists for the province. However, a specific density estimate was produced for 1996 and 1997 in the northern Columbia Mountains, where researchers estimated the density of wolverines at approximately 25 wolverines in the 4000 km² study area, or 1 wolverine/160 km² (Krebs and Lewis 2000). This estimate is not substantially different than the estimate produced for the south-western Yukon of 1 wolverine/177 km² (Banci and Harestad 1990). It is not known how applicable these estimates are to other areas in the province.

The relative ability of a population to remain stable or increase is largely dependent upon the survivorship of individuals within it. In a review of population vital rates of wolverines in western North America from 11 research studies, Krebs et al. (2000) determined that survivorship rates of wolverines varied depending upon whether the population was from tundra, boreal, or temperate regions and if the population was exposed to trapping. The highest survivorship rates were among the tundra-untrapped populations, while the lowest were among the temperate-trapped populations. They also concluded that human-caused mortality (e.g., trapping) is additive, not compensatory. Using this as a framework, wolverine populations are probably healthiest in the northern, inaccessible mountain regions of the province. Populations in the southern half of the province that are exposed to human development and trapping pressure likely have poorer survivorship and are thus more tenuous. Kyle and Strobeck (2001) speculated that the high degree of genetic isolation among the wolverines in the northern Columbia Mountains was due to a lack of connectivity between subpopulations and indicated an isolated population that may be more susceptible to stochastic events.

Habitat trends

The suitability of habitat in much of the range of the wolverine has declined over the past 30 years. Conversion of large, contiguous tracts of mature and old forests have likely affected the diversity and abundance of prey and carrion available to wolverines and likely affected the permeability of the landscape for dispersal. Development of previously inaccessible watersheds has introduced trapping mortality and transport-related (i.e., roads, rail) mortality into previously unharvested populations. Logging of high elevation forests may also influence the availability or success of natal and maternal dens.

Threats

Population threats

As noted by Banci and Proulx (1999), wolverine populations have low resiliency to population perturbation (e.g., fur trapping) because of their low densities, large home range sizes, and relatively low reproductive rate. Wolverine populations are believed to sustain a harvest rate of 6% of the population per year (Krebs et al. 2000). Recent analysis of wolverine survivorship has suggested that trapping mortality is additive, not compensatory (Krebs et al. 2000). Historic overharvest of wolverines has certainly contributed to their North American decline. A changing prey base, mediated by habitat and population manipulations by humans, may have also been a source of population decrease over the past 100 years. The primary population threat is the additive mortality resulting from fur harvesting. The increased access provided by forest development greatly enhances the ability of trappers to harvest wolverines in previously inaccessible areas.

Wolverines may also be very sensitive to disturbance particularly disturbance from roads and recreational activities (e.g., heli-skiing, snowmobiling).

Habitat threats

As stated by Banci (1994), the cumulative impacts of trapping, habitat alterations, forest harvesting, and forest access on wolverine populations are not well understood. Although wolverines are not widely reported to be a habitat specialist, habitat loss and alienation are commonly thought to be a major contributing factor to population declines (Banci 1994). The major habitat threat is the large-scale conversion of mature and old forest structural stages into early structural stage habitats. Logging of high elevation forests may also affect rearing success.

Legal Protection and Habitat Conservation

Under the provincial *Wildlife Act,* wolverines are protected from killing, wounding, and taking, and legal harvest for their pelts is regulated. Intentional harvest of wolverines is not permitted in regions 1, 2, and 8. Open trapping seasons on wolverines occur in regions 3, 4, 5, 6, and 7. There is no quota for harvests of wolverines in these regions but trappers must report the capture of wolverines within 15 days following the end of the trapping season. As recorded in the Fur Harvest Database, an average of 168 wolverines were harvested annually over the past decade (Lofroth 2001). Unreported harvests and discrepancies in the harvest reporting system suggest that the actual harvest of wolverines in British Columbia may be different (I. Adams, pers. comm.). Wolverines are also considered "small game" and may be hunted in regions 4, 6, and 7. The annual bag limit for these regions is one wolverine.

Areas protected from timber harvest and trapping are likely an important component of conservation of wolverines in British Columbia (Hatler 1989). Because of large space requirements, low density, and low resiliency to trapping, these refugia are likely critical to the persistence of wolverines in many landscape units. Several parks likely include suitable habitat for wolverines (e.g., Glacier National Park); however, wolverines have very large home ranges and most parks in British Columbia are not large enough to encompass the home range of a wolverine.

Several provisions of the results based code should maintain small-scale habitats for wolverines including recommendations for landscape unit planning and riparian management. Wildlife habitat features may also be used to manage den sites. However, because wolverines occur at low densities and cover large areas, maintaining wolverine habitat will also need to be implemented through higher level plans.

Identified Wildlife Provisions

Effective management of wolverine habitat needs to occur at the landscape spatial scale. Maintaining refugia (i.e., areas with limited resource and recreational activities and trapping), seasonal foraging areas, secure denning sites, adequate movement corridors, and limiting mortality within populations need to be implemented for successful conservation of the species. These issues can best be addressed by incorporating the connectivity of habitats, creation of refugia, and the arrangement and timing of forest development in strategic level plans.

Sustainable resource management and planning recommendations

- ❖ Refugia are probably the single most important landscape planning mechanism for the conservation of wolverine populations in British Columbia. Refugia should be designed using suitable portions of watersheds in juxtaposition with protected areas and no trapping areas that are determined in consulation with the Fish, Wildlife and Allocation Branch of the Ministry of Water, Land and Air Protection, and as part of a recovery planning process.
- ❖ Plan forest development to occur on one side of a watershed at a time where practicable. Limiting concurrent development will concentrate the activity at any one time and allow wolverines to avoid operational areas as much as possible during their daily movements. This will reduce the mortality risk (e.g., road kill, trapping) and displacement associated with forest development and will help facilitate normal movement throughout the landscape.
- ❖ Minimize road access (i.e., number of km and length of time active). The increase in access associated with forest development into previously pristine areas (especially large drainages) exposes resident wolverines to a much higher mortality risk from hunting, poaching, and road traffic. Careful road planning and deactivation should be considered.

- ❖ Maintain seasonal foraging areas. Seasonal foraging areas can be maintained through the appropriate juxtaposition of structural stages throughout a watershed. Adequate foraging habitat for wolverines is likely closely linked to the suitability of habitats to support their primary food sources (ungulates, snowshoe hares, porcupines, marmots). Maintaining these habitats near adequate thermal and security cover (generally mature and old forest structural stages) will be important to securing seasonal foraging areas for wolverines. In mountainous regions, this will entail planning for seasonal prey across several biogeoclimatic zones (e.g., ICH, ESSF, AT).
- ❖ Maintain suitable denning sites. Suitable sites are secure and undisturbed, and have the appropriate structure (see "Important habitats and habitat features" above). These need to be close to reliable food sources (carrion from late winter avalanches, prey) and are likely best supplied in the ecotone of the ESSF/ESSFp/ATp.
- ❖ Minimize disturbance at suitable denning sites. Logging should not occur near identified avalanche chutes or late-winter areas for caribou. Forestry operations should not occur in these areas between March and June when females are more sensitive to human disturbance. In areas without a diversity of elevations (and resulting BEC zones), additional factors will need to be taken into consideration to ensure the provision of secure den sites for wolverines. In relatively flat areas, such as the Fraser Plateau, denning wolverines may be more vulnerable to the effects of habitat alterations because their dens are more likely to occur in harvestable areas.
- ❖ Retain suitable movement and dispersal corridors. Habitat connectivity within and between watersheds is very important for successful daily movements, foraging, and dispersal of wolverines. Connectivity of valley bottom habitats is important, specifically along watercourses. These corridors should be dominated by older forests (stage 6 or 7) and it is important to connect, not only the valley bottom habitats, but also provide movement corridors between the valley bottom and patches of ESSF/AT habitats. Large connectivity corridors should be maintained between refugia where human disturbance is prevalent. These should also be dominated by older forests (stages 5–7).

Additional Management Considertaions

Minimize disturbance from recreational activities (e.g., heli-skiing, snowmobiling) near maternal dens.

Information Needs

1. Ecology in non-mountainous landscapes.
2. Dispersal through fragmented landscapes.
3. Reproductive rates.

Cross References

Fisher, Caribou

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Bighorn Sheep

Ovis canadensis

Original[1] prepared by R.A. Demarchi

Species Information

Taxonomy

Until recently, three species of Bighorn Sheep were recognized in North America: California Bighorn Sheep (*Ovis canadensis californiana*), Rocky Mountain Bighorn Sheep (*O. canadensis canadensis*), and Desert Bighorn Sheep (*O. canadensis nelsoni*). As a result of morphometric measurements, and protein and mtDNA analysis, Ramey (1995, 1999) recommended that only Desert Bighorn Sheep and the Sierra Nevada population of California Bighorn Sheep be recognized as separate subspecies. Currently, California and Rocky Mountain Bighorn sheep are managed as separate ecotypes in British Columbia.

Description

California Bighorn Sheep are slightly smaller than mature Rocky Mountain Bighorn Sheep (McTaggart-Cowan and Guiguet 1965). Like their Rocky Mountain counterpart, California Bighorn Sheep have a dark to medium rich brown head, neck, and dorsal body with a short black tail and a white muzzle, rump, and ventral patches. Both sexes have sturdy muscular bodies and strong necks that support horns that curve back in females and are much larger and curled around in males. The most consistent anatomical feature distinguishing the California ecotype from the Rocky Mountain ecotype is the presence of a continuous black or brown dorsal stripe dividing the white rump patch to the to the tip of the tail (Toweill 1999).

Distribution

Global

The genus *Ovis* is present in west-central Asia, Siberia, and North America (and widely introduced in Europe). Approximately 38 000 Rocky Mountain Bighorn Sheep (Wishart 1999) are distributed in scattered patches along the Rocky Mountains of North America from west of Grand Cache, Alberta, to northern New Mexico. They are more abundant and continuously distributed in the rainshadow of the eastern slopes of the Continental Divide throughout their range.

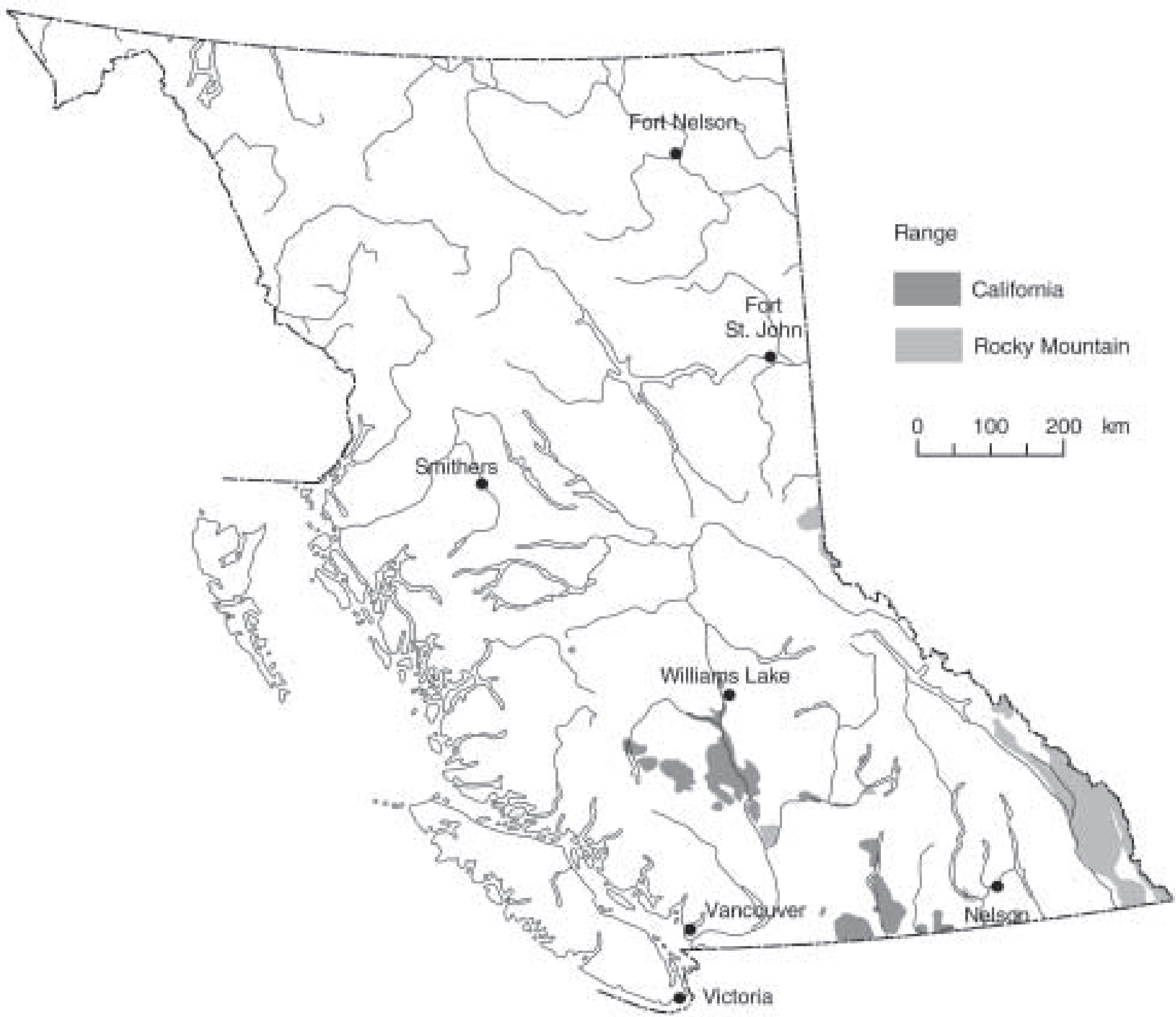
California Bighorn Sheep were extirpated from most of the United States by epizootic disease contracted from domestic sheep in the 1800s with a small number living in California until 1954 (Buechner 1960). Since 1954, Bighorn Sheep have been reintroduced from British Columbia to California, Idaho, Nevada, North Dakota, Oregon, Utah, and Washington, resulting in their re-establishment in much of their historic range. By 1998, California Bighorn Sheep were estimated to number 10 000 (Toweill 1999).

British Columbia

British Columbia's major native Rocky Mountain Bighorn Sheep population is distributed in herds in the Rocky Mountains of the East Kootenay region of southeastern British Columbia between the Kicking Horse River in the north and the U.S. border in the south, including one small herd that ranges into Montana east of Eureka during the summer months. British Columbia's population is connected at both extremes and at scattered locations along its range with sheep herds in Alberta. Separate herds winter in

1 Volume 1 account prepared by D. Spaulding.

Bighorn Sheep
(Ovis canadensis)



Note: The map is based on current knowledge of the species' distribution.
This species may or may not occur in all areas indicated.

either province, with several small herds wintering on or immediately adjacent to the summit of the continental divide (Kakwa, Simpson River, Ewin Ridge, Sheep Mountain, Deadman Pass, and Crowsnest Pass herds). There are introduced herds of Rocky Mountain Bighorn Sheep in the Spences Bridge, Squilax, and Castlegar areas. There is a herd near Salmo as a result of a natural expansion by a transplanted herd from the Hall Mountain area of northeast Washington.

California Bighorn Sheep in British Columbia have undergone a considerable reduction in distribution and abundance since primitive times (Buechner 1960; Sugden 1961). Originally, California Bighorn Sheep were in the arid grasslands of the valleys of the Fraser, Thompson, Nicola, Lower Bonaparte, Okanagan, Ashnola and Similkameen Rivers, along the higher valleys west of the Fraser River, Bridge River, Seton Lake, Anderson Lake, Taseko Lake, Chilko Lake, Tatlayoko Lake, and Mosley Creek (Sugden 1961). California Bighorn Sheep probably disappeared in the Thompson, Nicola, and lower Bonaparte before Euro-Asian contact (Sugden 1961). Significant reductions in populations have since occurred in the Similkameen (i.e., Ashnola) and Okanagan areas.

California Bighorn Sheep were successfully reintroduced to the Thompson River watershed above Kamloops Lake in the 1960s, and to the Kettle-Granby watershed in the 1980s. Today, British Columbia's native California Bighorn Sheep population is distributed in herds in the Okanagan-Similkameen, Thompson, Fraser, and Kettle-Granby river watersheds. These populations are not continuously connected as they are fragmented into herds that have limited interchange and are considered separate metapopulations (Demarchi et al. 2000).

Ecoprovinces and ecosections

California ecotype

CEI: CAB, CCR, CHP, FRB, WCU

SOI: OKR, NOB, NOH, NTU, PAR, SCR, SOB, SOH, STU, THB

Rocky Mountain ecotype

SBI: HAF, NHR, SHR

SIM: COC, CPK, EKT, FRR, NPK, SCM, SFH, SPK

SOI: NTU, PAR, THB

Biogeoclimatic units

California ecotype

AT: p, un

BG: xh1, xh2, xh3, xw1, xw2

ESSF: dv, dvp, xc, xcp, xv

IDF: dk1, dk2, dk3, dk4, dm1, mw2, xh1, xh2, xm, xw

MS: dc1, dc2, dm1, dm2, xk, xv

PP: dh1, xh1, xh2

SBS: mh

Rocky Mountain ecotype

AT: p, un

BG: xh2, xw1

ESSF: dk, dkp, mm2, mv2, wc1, wc3, wc4, wm, xc, xcp

ICH: dw, mk1, mw2

IDF: dk1, dk2, dm2, un, xh2

MS: dk, xk

PP: dh2, xh2

SBS: dh

Forest region and districts

	Forest districts	
Forest region	**California ecotype**	**Rocky Mountain ecotype**
Southern Interior:	100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin, Kamloops, Okanagan Shuswap	Arrow Boundary, Cascades, Columbia, Headwaters, Kamloops, Kootenay Lake, Okanagan Shuswap, Rocky Mountain,
Northern Interior:		Prince George, Peace

Broad ecosystem units

AC, AB, AG, AM, AU, BS, DF, DL, DP, EF, FP, LP, MS, OV, PP, RO, SD, SG, SM, SS, TA

Elevation

The California ecotype generally occurs between 300 to 2800 m; whereas the Rocky Mountain ecotype generally occurs between 500 and 3000 m but does occur as low as 175 m at Spences Bridge where they were introduced.

Life History

Diet and foraging behaviour

Valdez and Krausman (1999) present a comprehensive review of the diets of both California and Rocky Mountain Bighorn Sheep. They state that in any given habitat, the percentages of graminoids, forbs, and shrubs in the diet of Bighorn Sheep may vary. Generally, the winter diet of Bighorn Sheep consists of mainly graminoids with lesser consumption of forbs, shrubs, and some conifers. Summer range is often alpine areas with grasses, sedges (*Carex* spp.), and a diversity of forbs used as forage. Grasslands and seral shrublands in the East Kootenay Trench Ecosection provide forage mainly from bunchgrasses such as wheatgrass (*Agropyron* spp.), fescues (*Festuca* spp.), bluegrass (*Poa* spp.), and needle grasses (*Stipa* spp.), and various forbs and shrubs (Davidson 1991).

In the Elk Valley, the diet pattern reflected the phenological plant development from spring to mid-summer. Sheep forced by deep snow to stay on high-elevation winter ranges until early summer consumed proportionately more graminoids (59%) than sheep from grasslands in the mid-elevation Montane Spruce biogeoclimatic zone (28%) (TAESCO 1982). Forbs (57%) and shrubs (14%) dominated the diet of the latter. In comparison, during spring and summer the alpine-wintering sheep used fewer shrubs (3%) but also heavily utilized forbs (36%). Conifers constituted a low percentage of the diet for both although more conifers were used in spring and summer by the alpine-wintering sheep.

In a study near Penticton, the California Bighorn Sheep studied utilized 14 grass species, 47 forbs, and 18 woody species (Wikeem and Pitt 1992). Bunchgrasses such as bluebunch wheatgrass (*Pseudoroegneria spicata*), junegrass (*Koeleria* spp.), and fescues, bluegrass, needle grasses, and various forbs and shrubs were eaten (Blood 1967; Demarchi 1968; Wikeem 1984; Wikeem and Pitt 1992). Scree slopes and cliffs are generally vegetated with shrubs that can be important to foraging such as gooseberry (*Ribes* spp.), cinquefoil (*Potentilla* spp.), sagebrush (*Artemesia* spp.), rose (*Rosa* spp.), maple (*Acer* spp.), saskatoon (*Amelanchier alnifolia*), kinnikinnick (*Arctostaphylos uva-ursi*), juniper (*Juniperus* spp.), and blueberry (*Vaccinium* spp.).

Reproduction

As with most northern ungulates, the rut is timed to optimise the availability of abundant nutritious forage at parturition (Bunnell 1982; Hebert 1973; Thompson and Turner 1982). Typically, in British Columbia rutting occurs from early November to early December with parturition occurring around 175 days after conception beginning in early June, peaking in mid-June, and ending the first week of July (Demarchi 1982; Shackleton 1999). Bighorn Sheep herds that live at high elevation all year appear to rut 1–2 weeks later.

Introduced Bighorn Sheep have the potential to double their numbers in approximately 3 years (Wishart et al. 1998). Pregnancy rates have been shown to be over 90% of adult females and bearing one young per year (Haas 1989; Jorgenson 1992). Fecundity and survival favour rapid population growth at low population density and conservative population strategies at densities approaching carrying capacity (Ricklefs 1982 in Wishart 1999). In addition, the California Bighorn Sheep ecotype occasionally produces twins thereby adding to potential productivity (Blood 1961; Spalding 1966)

Site fidelity

Generally, female Bighorn Sheep show fidelity to home range (Geist 1971; Festa-Bianchet 1986; Stevens and Goodson 1993). Both sexes have a strong home range fidelity to a particular mountain, but generally, ewes return rate to a specific range is higher than males. Geist (1971) found that ewes returned to the same range 90% of the time while rams returned 75% of the time.

Home range

Bighorn Sheep are gregarious but live in sexually segregated groups (Geist 1971). Male Bighorn Sheep use as few as two and as many as six separate home ranges during a year. The ranges of major ram bands can include pre-rut, rutting, mid-winter, later-winter/spring, and summer ranges (Geist 1971). Some Rocky Mountain Bighorn Sheep winter and summer at high elevation but on separate mountains, such as all of the Elk Valley herds. The herds in the East Kootenay Trench, however, winter at low elevation and summer at high elevation. Generally, ewes use two to three seasonal ranges (Wishart 1978; Geist 1971; Shackleton 1973; Festa-Bianchet 1986) but Bighorn ewes can use as many as four ranges including winter, spring, lambing, and summer ranges (Geist 1971; Festa-Bianchet 1986).

Home ranges are usually part of a mountain, or a whole mountain. Of the four ungulate species studied on Premier Ridge in the East Kootenay, Bighorn Sheep were the most localized and specific in their response to environmental factors such as slope and rockiness (escape terrain) and they tended to use small, rather specific areas (Hudson et al. 1975). Home ranges can be as small as 0.8 km^2 in mid-winter or as large as 5.9 km^2 in spring and fall (Geist 1971). The high elevation winter range for the Ewin herd of approximately 150 sheep was 1.4–2 km^2 (TASECO 1982). This means that 0.47–0.50 ha would be required to support one ewe based on grazing capacity (average forage requirement of 30 kg/sheep and a grazing time of 5 months). Kopec (1982) found home ranges averaged 541 ha for ewes and 798 ha for rams in Montana. Ewes' home ranges were the smallest during lambing (47 ha) and largest during the fall, 273 ha. The rams' smallest range was in winter range (averaging 21 ha) and the largest during the spring range (averaging 305 ha). The size of lambing areas ranged from 3 to 150 ha in Idaho (Akenson and Akenson 1992). In Montana, Semmens (1996) estimated home range size for lamb-ewe groups from 6.4 to 32.9 km^2 using radio-telemetry data from three subpopulations.

Movements and dispersal

Seasonal home ranges may vary considerably between Bighorn Sheep herds, not only in size, but also in the distance to other seasonal home ranges. The separation of one seasonal range from another can be one steep gorge or it can be distances of 10–70 or more kilometres between summer and winter ranges for California Bighorn (Blood 1961; VanSpall and Dielman 1997) and 24 to >51 km for Rocky Mountain Bighorn. Ewes in central Idaho migrated 1–40 km from winter ranges to lambing ranges (Akenson and Akenson 1992). Unlike Rocky Mountain Bighorn Sheep observed by Geist (1971), the radio-collared California Bighorn Sheep studied in the Churn Creek watershed (Fraser River meta-population) did not demonstrate a difference between sexes in the timing of either spring or fall migrations. Ewes and rams migrated concurrently between the summer and the rutting/wintering areas, spending approximately 8 months on the winter range (Keystone Wildlife Research 1998). However, high water flows did delay spring migrations of ewes accompanied by lambs.

In late September or early October, large bands of rams move to a fall concentration area where they generally stay from 2 to 5 weeks. From this pre-rut range in the first week of October or the first week in November, they disperse to rutting grounds until the end of December (Geist 1971; TAESCO 1982). At this time some rams will return to pre-rut home range while others move to mid-winter home ranges where they spend 271–303 days (Geist 1971). Some young rams and the ewes will remain at the rutting grounds. By mid-March, rams return to fall concentration areas. In summer, the rams move to salt licks for a few weeks and then to summer range.

Ewes arrive later on the wintering areas and depart earlier, spending 240–268 days on wintering areas (Geist 1971). The fall concentration area or areas immediately adjacent will usually be where the ewes remain in the winter. In late March or April, separate winter/spring range may be used once the snow hardens or is reduced enough to allow movement. Females move to lambing areas in late May or June or, infrequently, at the beginning of July. Pregnant ewes were found to move from higher quality forage to an area of lower quality to provide better protection from predation (Festa-Bianchet 1988). Lambing may take place on the winter range or in a separate lambing range. In late June or early July, barren females, juveniles, and rams move to summer ranges.

Habitat

Structural stage

Ecotype	Foraging	Security & thermal	Lambing	Rutting
California	2–3 & 6–7	4–7	1–3	1–3 & 6–7
Rocky Mountain	2–3 & 6–7	4–7	1–3	1–3 & 6–7

Important habitats and habitat features

Bighorn Sheep use a variety of habitat types within their home ranges. Habitats include open grasslands, alpine, subalpine, shrub-steppe, rock outcrops, cliffs, meadows, moist draws, stream sides, talus slopes, plateaus, deciduous forest, clearcut or burned forest, and conifer forest, all on moderately steep to steep slopes. Use of habitat varies daily and seasonally with changes in requirements for food, rest, safety, thermal cover, rutting, and lambing (Risenhoover and Bailey 1985). Table 1 summarizes coarse habitat requirements used for Bighorn Sheep. Rocky Mountain Bighorn Sheep prefer habitats with steep grasslands and broken krummholz terrain (Demarchi 1986).

California Bighorn Sheep in British Columbia exhibit three seasonal habitat use strategies. The majority of populations winter on low-elevation, southerly exposed slopes close to rocky escarpments or scree slopes, and summer in high elevation alpine and subalpine areas (Blood 1961; Sugden 1961). However, there is a population that spends both summers and winters on high-elevation, windswept alpine ridges and mountains (e.g., the Taseko, Elbow/Dash/Relay, Shulaps, and Yohetta/Tatlow herds) (P. Dielman and F. Harper, pers. comm.). Another herd spends the winters and summers at low elevations along the Fraser River canyon in the Fraser River Basin Ecosection (e.g., the entire Junction herd and part of the Churn Creek, Fraser River East, and Fraser West populations) (Demarchi and Mitchell 1973; Keystone Wildlife Research 1998; F. Harper, pers. comm.).

Table 1. Coarse feature requirements of Bighorn Sheep (after Sweanor et al. 1996)

Habitat requirement	Definition
Escape terrain	Areas with slope >27° and <85°
Escape terrain buffer	Areas within 300 m of escape terrain and areas ≤1000 m wide that are bound on ≥2 sides by escape terrain
Vegetation density	Areas must have visibility >55%, as defined by the mean percentage of squares visible on a 1 m^2 target, divided into 36 equal squares, 14 m from an observer viewing N, E, W, S from a height of 90 cm along a 10 pt, 280 m transect
Water sources	Areas must be within 3.2 km of water sources
Natural barriers	Areas that Bighorn Sheep cannot access are excluded (e.g., rivers >200 ft^3/s, areas with visibility <30% that are 100 m wide, cliffs with >85° slope)
Human use areas	Areas covered by human development are excluded
Man-made barriers	Areas that cannot be accessed due to man-made barriers are excluded (e.g., major highways, wildlife-proof fencing, aqueducts, major canals)
Domestic livestock	Areas within 16 km of domestic sheep and domestic goats are excluded

Thermal and security cover

Forests (pole/sapling to old forest) are used for security and thermal cover. Bighorn Sheep, and most commonly non-habituated groups of rams, use dense conifer forests as hiding cover when disturbed by lightening storms, motorized vehicles, and humans on foot. Mature, open forests provide Bighorn Sheep with important habitats for forage and thermal cover (Demarchi and Mitchell 1973). During a recent low temperature/deep snow event in the Ashnola watershed, California Bighorn Sheep retreated to old-growth Douglas-fir (*Pseusdotosuga menziesii*) forests, presumably to escape deep snow and to seek forage from Douglas-fir needles, twigs, and litter-fall (R. Lincoln, pers comm.). Scree slopes and rock outcrops within coniferous forests are also used as hiding cover by rams during the hunting season, and for thermal cover during hot weather. High elevation wintering Bighorn Sheep retreat to the upper margins of mature montane spruce forest during severe inclement winter weather.

Wintering

Bighorn Sheep depend on natural grasslands such as bunchgrass, ranges (especially bluebunch wheatgrass [*Pseudoroegneria spicata*] and rough fescue [*Festuca scabrella]*) and early successional forest stages: particularly as winter range for all ecotypes (Blood 1961; Sugden 1961; Demarchi and Mitchell 1973; Wikeem 1984; Demarchi 1986; Davidson 1991).

Rocky Mountain Bighorn Sheep winter on low-elevation, southerly exposed slopes close to rocky escarpments or talus slopes (Shackleton 1973; Demarchi 1986). However, two other populations in the East Kootenay winter on high-elevation, wind-swept, alpine, and subalpine ridges (TAESCO 1982; Demarchi 1986; Shackleton 1973) or winter in exposed south-facing grassland slopes at mid-elevation in the montane forest of the Fording Valley (Demarchi 1968, TAESCO 1982). Although the three populations are spatially separated, their habitat and forage requirements are similar (e.g., mineral licks, migration corridors, and proximity to escape terrain for security from predators—especially during lambing).

Use of grasslands and seral shrublands in the East Kootenay Trench ecosections by Bighorn Sheep occurs mainly during winter. Rams often use more marginal habitats on cliffs and rugged terrain (TAESCO 1982).

Lambing

Females move to lambing areas to give birth any time from early May through June, or less frequently, the beginning of July. Lambing may take place on the winter range or in a separate lambing range. Southerly and south-westerly-facing scree slopes and steep rugged terrain interspersed by rock cliffs are commonly used for lambing. Talus slopes and cliffs are commonly sparsely vegetated but provide habitat for lambing, and general security. Lambing range selection may be based on a combination of nutritional and anti-predator constraints. These sites may be sparsely vegetated but provide relatively secure habitat for birthing, nursing, and resting away from both terrestrial and aerial predators. Pregnant ewes were found to move from higher quality forage to an area of lower quality to provide better protection from predation (Festa-Bianchet 1988).

Spring/summer

Summer range is often in high elevation rocky alpine and krummholz areas (Shackleton 1973; Demarchi 1986). In Ewin Creek of the East Kootenay, ewes summered in the lower elevation forests without forming distinct nursing bands (TAESCO 1982). As with the lower elevation wintering herds, the two high elevation wintering ecotypes summer in the alpine and in subalpine forests.

Rutting

For the California ecotype, rutting ranges are often encompassed by the winter and/or lambing areas. For the Rocky Mountain ecotype, large bands of rams move to a fall concentration area or pre-rut range in late September or early October where they generally stay from 2 to 5 weeks. They disperse from this area in the first week of October or the first week in November to rutting grounds that are usually the same areas used as winter range by the ewe-juvenile component of the herd. The rams remain there until mid- to late December. At this time, some rams will return to the pre-rut home range while others move to mid-winter home ranges where they spend 271–303 days (Geist 1971). Some young rams and the ewes and juveniles will remain at the rutting grounds. By mid-March rams return to their fall concentration areas prior to migration to summer range.

Mineral licks and watering holes

Bighorn Sheep return repeatedly to localized areas that are used as mineral licks and watering holes. These are specific to individual herds and individual herds will often use more than one mineral lick or watering hole. Access to potable water in locations secure from predation is important, particularly when ewes are accompanied by suckling lambs.

Mineral licks are an important source of essential minerals for most mountain ungulates. Certain trace minerals such as selenium and copper have been suggested as being limiting in some habitats (Schwantje 1988). This may be especially true for Bighorn Sheep herds in British Columbia because soil mineral content is low throughout their distribution (Van Dyke 1978) and this may result in some forage with low mineral content (Smith 1954). Hebert (1973) found that diets based on high altitude forages had higher levels of essential trace minerals than those at lower altitudes. Mineral content among licks varies considerably (Dormar and Walker 1996) suggesting that (1) various types of licks may serve different needs, and (2) sheep use more than one lick site. Deficiencies of trace minerals such as selenium and copper are responsible for reduced immune function in other ungulate species and may contribute to outbreaks of disease in Bighorn Sheep (Packard 1946; Schwantje 1988).

Conservation and Management

Status

Bighorn Sheep are on the provincial *Blue List* in British Columbia. Their status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	WA	ID	MT	Canada	Global
S2S3	S3	S3S4	S3	S4	N3	G4

Trends

Population trends

The population of California Bighorn Sheep in British Columbia includes five metapopulations, two of which—the south Okanagan and Kettle-Grandby metapopulations—encompass small isolated populations in northern Washington. The population of Rocky Mountain Bighorn Sheep in British Columbia is part of a core-satellite metapopulation of approximately 18 000 Rocky Mountain Bighorn Sheep in British Columbia, Alberta, and part of Montana, with the core situated in Alberta.

A minimum viable population of 125 has been determined for Bighorn Sheep at the subpopulation level (Berger 1990). Of the 10 subpopulations of California Bighorn Sheep in British Columbia, two are extremely small at <20 individuals, one is <125, and seven are ≥125. Of the 14 subpopulations of Rocky Mountain Bighorn Sheep in British Columbia, six are <125 individuals, and eight are ≥125.

British Columbia's California Bighorn Sheep population was estimated to be 3030–3625 in 1998, the last year of record. There was an increasing trend in both numbers and populations of California Bighorn Sheep from the early 1960s through the 1980s (Ritcey and Low 1986) and into the early 1990s (B.C. MELP 1998). The provincial population of California Bighorn Sheep increased from 1760 in 1970 to 3240 in 1985 and then to 4650 in 1990. By 1998, the population had declined to 3630 (B.C. MELP 1998; Toweill and Geist 1999). This sudden decline was largely a result of very low lamb survival amongst herds in the Fraser Basin and a die off caused by severe winter conditions in the Ashnola in 1990–1991. In 1999–2000, the central herd in the south Okanagan near Oliver, B.C., suffered a severe all age die-off, further reducing their numbers and heightening agency and public concerns for future population trends (Harper et al. 2001).

The population size of Rocky Mountain Bighorn Sheep in British Columbia was approximately 3000 in 1996, the most recent year of record. This is the largest size that inventory figures have recorded, although there may have been a larger population pre-historically when grasslands were probably more widespread. The distribution has not changed significantly from the early part of the 20th century.

Regular cyclic die-offs have dramatically affected population numbers and trends, approximately every 20 years beginning in the early 1920s (Davidson 1991). Following recovery of the last, early 1980s die-off, the population trend for Rocky Mountain Bighorn Sheep was generally upward until 1996, but there has been a subsequent decrease.

Reduced lamb survival and other contributing factors continue to be problematic for some herds. For example, a small-scale outbreak of bacterial pneumonia occurred in the Elk Valley in the fall in the late 1990s, however, this appeared to have been self-limiting as there were no further reports of sick or dead sheep following the rut (H. Schwantje, pers. comm.). Also, a significant loss of California Bighorn Sheep was caused by the translocation of mature animals from several herds between the 1950s and 1990s.

Habitat trends

An increasing amount of the traditional winter and spring habitat of Bighorn range is being alienated and/or developed for residential, agricultural, and industrial purposes. Such conflicting land uses have been and will be inevitable, because low elevation bighorn habitat is often some of the most desirable for human development. For the Rocky Mountain Bighorn Sheep, the capability of the habitat has been diminished by permanent factors such as land alienation, highways, subdivisions, and open-pit mines by <10% (Demarchi and Demarchi 1994). The suitable habitat at present is <50% of the capable habitat within the historic distribution because of forest access roads, forest succession, competition with livestock, and human disturbance. In addition to the direct loss of habitat, conifer encroachment onto native grasslands and loss of seral-shrub-grassland range have been accelerated by aggressive fire suppression practices of the provincial Ministry of Forests over the past 40 or more years. Conifer tree encroachment has occurred at a rate of 0.5–2%/yr on low-elevation winter ranges (Davidson 1991). Based on the observations of wildlife managers, the rate of winter habitat change is considered "rapid." California Bighorn Sheep managers have expressed concerns for the loss of habitat through forest fire suppression and forest succession (T. Ethier, D. Jury, D. Low, and J. Youds, pers. comm.). Critical winter range habitat has been significantly reduced throughout the Rocky Mountain Bighorn Sheep's range (≤50%) over the last 70 years. Due to their higher moisture regimes, encroachment has been even greater on spring and fall transition ranges. The loss of transition ranges forces Bighorn to arrive on winter ranges earlier and leave later (increased sedentariness). Overused winter ranges cause nutritional stress and can increase parasite (especially lungworm) infection rates leading to increased lung damage.

Threats

Population threats

Factors predisposing the south Okanagan Bighorn Sheep population to a disease die-off in 1999–2000 include probable disease transmission from domestic sheep, trace mineral deficiencies, habitat effects from urban and agricultural development, weed invasion, fire suppression, increased predation, range depletion, and forage competition with livestock and wild ungulates and harassment by humans and dogs (Harper 2001). Stressors implicated in East Kootenay Bighorn die-offs have included poor nutrition, trace mineral deficiencies, high animal density, inter-specific competition, inclement weather, harassment by humans and dogs, and high levels of parasites.

Livestock ranching is the primary threat to Bighorns through disease transmission, range depletion, and resource competition. A definite cause-and-effect relationship exists between bacteria, such as *Pasteurella* species, carried by domestic sheep and transmitted to mountain sheep. This relationship has been suspected since at least 1954 (Smith 1955) and proven since 1982 (Foreyt and Jessup 1982). *Pasteurella* species, commonly present in domestic sheep, can induce fatal pneumonia in otherwise healthy bighorns from nose-to-nose contact (Foreyt and Jessup 1982; Onderka 1986; Onderka and Wishart 1988).

High levels of lungworm (*Protostrongylus stilesi*) infection can cause high mortality in Bighorn lambs. Although Bighorns and this species of lungworm have coevolved, the developing stages can cause significant damage to lung tissue. Any habitat factor that improves survival of lungworm larvae, their intermediate host (i.e., terrestrial snails), or their rate of ingestion will increase lungworm loads in Bighorns. Higher animal infection rates have been associated with higher soil moisture levels. Irrigated agriculture fields that attract Bighorn Sheep may exacerbate the problem since the high animal density, increased grazing pressure, and increased number of lungworm-carrying snails ingested may lead to higher infection rates (Harper 1995; P. Dielman and H. Schwantje, pers. comm.). Added to this, these sheep may prefer to live year round on such habitat and lose their normal home range movements and behaviour.

The harassment of wildlife by the presence of humans, whether in the form of wildlife viewing stands, aerial censuses, snowmobiles, helicopters, vehicles, or domestic dogs, can add undue stress to vigilant species such as Bighorn Sheep (MacArthur et al. 1982; Krausman and Hervert 1983; Stemp 1983; Legg 1998). During the third trimester and while lactating, ewes are particularly sensitive to human disturbance as they move frequently in search of high quality forage (Wagner and Peek 1999).

Predation is a possible limiting factor for Bighorn populations (Haas 1989). Eight carnivore and raptor species can prey on Bighorn, namely Grizzly Bear (*Ursus arctos*), Black Bear (*Ursus americanus*), Cougar (*Felis concolor*), Bobcat (*Lynx rufus*), Lynx (*Lynx canadensis*), Wolf (*Canis lupus*), Coyote (*Canis latrans*), and Golden Eagle (*Aquila chrysaetos*) (Kennedy 1948; Buechner 1960; Sugden 1961; McTaggart-Cowan and Guiguet 1965). Predation undoubtedly varies over space and time although coyotes, cougar, and grizzly bears are suspected to take a considerable portion of the annual production. Bighorn Sheep are less well adapted to avoiding the stalking and ambush techniques of cougars in rough terrain, particularly where there is tree or rock cover (Wishart 1999). Wehausen (1996) determined that cougar predation reduced the annual adult ewe survival to 62.5% and cougar predation accounted for 100% of all adult ewe mortalities in his study area. Hebert and Harrison (1988) studying California Bighorn Sheep in the livestock-free Junction herd concluded that coyote predation and not range condition, nutrition, stress, parasites, disease, or climate resulted in a significant loss of lambs. Harrison and Hebert (1988) also concluded that cougar predation and not habitat condition or illegal hunting reduced the number and proportion of mature rams in the Junction herd. Evidence was obtained in their study that supported the hypothesis that scavenging of cougar kills by coyotes increased the frequency of predation by cougar.

Livestock operations with inadequate methods of carcass disposal may inadvertently result in an increase or concentration of predators that in turn may lead to increased predation on adjacent Bighorn Sheep populations.

Habitat threats

A large domestic sheep industry and the free ranging of large numbers of horses on Crown range in the early to mid-1900s resulted in damage to fragile low elevation and alpine grasslands important to Bighorn Sheep in the interior in such places as the Yalakom and Ashnola valleys (Demarchi and Demarchi 1987).

Impacts from cattle grazing include reduced forage supply, abandonment of ranges, decreased distance to escape terrain, and altered habitat use patterns (Bissonette and Steinkamp 1996) in addition to depletion of range condition and trampling and fouling of watering holes and mineral licks. Plants may not support a second grazing by cattle if they are to support Bighorn Sheep the following winter and spring. While grazing lands can benefit from judicious management of cattle, they must be carefully managed to ensure Bighorns have the appropriate forage available at the critical times of year on the critical preferred habitats.

California Bighorn Sheep habitat has been permanently lost through subdivision development on traditional sheep range, particularly in the southern Okanagan and also near Grand Forks in the Kettle-Granby, through expansion of vineyards in the southern Okanagan and expansion of alfalfa and ginseng cultivation in the Fraser River Basin. Nearly 9000 ha of native grasslands were converted to agricultural and urban development in the southern Okanagan between 1940 and 1987 with a further 4000 ha projected to be lost over the next 20 years, if present trends continue (Harper et al. 2001).

Rocky Mountain Bighorn Sheep habitat has been permanently lost through urban development at Radium Hotsprings, Fairmont Hotsprings, and Elko and the golf course at Radium. Agricultural developments along the Galton Range and Bull River have been established on traditional Bighorn Sheep range. Acreages and subdivisions between Fairmont Hotsprings and Brisco also have the potential to disrupt north–south migration of Bighorn Sheep along the western edge of the Rocky Mountains (Davidson 1991). Approximately 25% of the winter range for Bighorns in the upper Columbia area has been accessed, subdivided, and developed for housing and industry since the 1940s (Davidson 1991).

Roads and railways (e.g., Highway 97 in Vaseux, Canadian Pacific Railway, Highway #1 at Spences Bridge, Highway #3, and the highway from Radium through Kootenay National Park) occupy habitat, dissect migration routes, and result in direct mortality. Salt used for road maintenance can attract and hold sheep in highway corridors. In some cases, significant numbers of adults have been lost in single seasons.

Industrial developments such as forestry, mining, and hydro-electric developments can result in habitat loss and displacement, disturbance, interference with seasonal movements along established secure corridors, and increases in animal exposure to predation. Helicopter activity associated with seismic work, forestry, and recreation can disturb and displace sheep.

Specific developments that have impacted Bighorn Sheep include the Aberfeldie Dam and Elko Dam; open-pit mining and overburden dumping in the Elk Valley which not only altered but completely destroyed Bighorn Sheep habitat in some areas (Demarchi and Demarchi 1987); Westroc Gypsum mine at Windermere; and Line Creek's open pit coal mine.

Other examples of development that have impacted Bighorn Sheep are historic developments such as the exploration for coal with heavy equipment in the Fernie Coal Basin of the Elk Valley in the late 1960s and early 1970s (Demarchi 1968, 1977), major seismic work throughout the Southern Rockies on both sides of the Continental Divide in the 1950s, and natural gas seismic activity in the Flathead in the 1980s.

Impacts from recreation such as ski resorts, all-terrain vehicles, rock climbing, golf, heli-skiing include habitat loss, disturbance, and foraging efficiency reduction (Stockwell et al. 1991; Bleich et al. 1994). The resulting chronic stress can lead to poor health, reduced growth, and reduced reproductive fitness (Geist 1979). Chronic disturbance can work additively with other habitat and animal factors and lead to immuno-compromised individuals or populations and result in outbreaks of disease. Sheep habituated to human disturbance may be susceptible to increased highway mortality, harassment by people and dogs, and dependency on artificial food sources that may be only temporarily available.

Forest encroachment and fire suppression are reducing suitable habitat by replacing grass, forbs, and deciduous shrubs with conifers. Forest succession can interfere with seasonal movement patterns and grazing behaviour because, as the density of trees increases, the visibility decreases, increasing predation by carnivores relying on stealth. Fire suppression alters the fire ecology of grasslands.

Competition for forage from elk and mule deer on low elevation winter ranges may be substantial

(Smith and Julander 1953). Elk numbers in the East Kootenay increased from about 7000 in 1974 to about 28 000 in 1980 (Davidson 1991). When resources are scarce, Bighorn Sheep ewes may postpone first reproduction (Festa-Bianchet et al. 1995) or reduce maternal care resulting in decreased lamb survival (Festa-Bianchet and Jorgenson 1998).

The introduction and spread of invasive species on grasslands are of great concern because they replace nutritious native forage species with inedible or non nutritious plants.

Legal Protection and Habitat Conservation

Where hunting seasons are permitted, Bighorn Sheep are normally harvested under a general open season male-only with specific horn curl minimums (e.g., full or ¾ curl). Limited entry hunting (LEH) authorizations, quotas, and administrative guidelines are used to regulate hunting in some areas. Limited ewe and lamb hunting are provided where sheep numbers are approaching or have exceeded carrying capacity. Annual management unit estimates, compulsory inspection, 3- to 5-year population monitoring, population modelling, and site-specific surveys are employed by the regional and provincial wildlife managers to monitor and regulate populations. Hunting can be an important management tool for Bighorn Sheep herds due to the potential for dramatic cyclical die-offs associated with exceeding the carrying capacity of ranges. A recent survey of sheep managers in North America indicated ram hunts and ewe hunts may be a cost effective means of controlling populations at or near carrying capacity (Hacker 1999).

The ranges of some herds are protected or partially protected by provincial protected areas including:

- Junction Sheep Range Provincial Park contains the year-round range of the Junction herd
- Churn Creek Park contains the winter range of the Churn Creek herd
- Big Creek/South Chilcotin contains the year-round range of the Park Elbow/Relay herd
- Lac du Bois Grasslands contains the Kamloops Lake peripheral winter range
- Marble Range and Edge Hills Parks contain the limestone summer and winter range of the East Fraser River herd
- Cathedral Provincial Park and the newly established Snowy Mountain Provincial Park contain the Ashnola herd
- Kootenay National Park contains half of the summer, half of the winter, and all of the transitional ranges of the Radium-Stoddart Creek herd
- Yoho National Park encompasses all of the summer range for the Golden herd
- Mount Assiniboine Provincial Park and adjacent Banff National Park encompass the entire range of the Assiniboine herd
- Height of the Rockies Provincial Park encompasses the entire range of the Quarrie and Bingay Creek herds
- Akamina-Kishinena Provincial Park includes the summer range for the Waterton (Alberta) herd
- Kakwa Provincial Park protects the summer range of the Kakwa herd
- Ilgachuz Range herd is protected year round by Itcha Ilgachuz Provincial Park.

The East Columbia Lake Wildlife Management Area and the Crown property on Mount Broadwood protect important Rocky Mountain Bighorn Sheep winter ranges. In addition, private land acquisition programs have acquired the Starr Ranch at Sheep Mountain, the Neilson property at Bull River, and private property at the east side of Columbia Lake. The size of parcels varies from a few hectares of strategically situated land to over 12 000 ha of prime winter range on Mount Broadwood on the Wigwam River. However, private inholdings in the Wigwam area threaten the integrity of the winter range.

Some key California Bighorn Sheep winter and summer ranges are partially or wholly encompassed by Indian Reservations. These include Ashnola (summer range), Vaseux, North Thompson, Dog Creek, and Nemaiah. Range condition on Indian Reservations varies but as many areas are subject to year-round grazing by cattle and/or horses it is generally classed as “fair to poor” condition. In addition, housing, commercial, recreational, and industrial developments such as the proposed 2000 lot subdivision and cable tram to the top of Mount St. Paul at the junction of the North Thomson and South Thompson rivers is expected to reduce the capability of the area to support Bighorn Sheep (F. Harper, pers. comm.). Housing and agricultural developments are among the greatest threats to maintaining the integrity of habitat in the southern Okanagan. Several non-governmental conservation organizations are actively pursuing a private land acquisition program.

A health protocol developed for domestic sheep used for vegetation management in British Columbia and Alberta was developed to ensure healthy domestic sheep access to forest lands for silvicultural purposes. Guidelines have been developed and include a review process whereby wildlife biologists are to document the presence of wild sheep and goat herds near the proposed vegetation management site. If these herds are present, the project is refused. The protocol and guidelines cannot address cattle, nor the presence of domestic sheep and goats on private land adjacent to Bighorn Sheep range. Livestock ranching and agriculture can play important roles the health of Bighorns (i.e., through disease transmission and resource competition). The recommendation of the Northern Wild Sheep and Goat Council is to provide a buffer of at least 4 km between wild and domestic sheep while others recommend 16 km (Sweanor et al. 1996). Recent guidelines used in British Columbia and Alberta are approximately 10 km, depending on natural barriers.

Access management in Bighorn Sheep habitat has centred around snowmobile and ATV uses of winter ranges and the restriction of motor vehicles for hunting. Employing the access provisions of the *Wildlife Act* to regulate road use for specific purposes provides only a partial, temporary solution to overuse of terrain resources and harassment of Bighorn Sheep. Establishing road closures for specific purposes while leaving the road open for other uses has only been a partial and often contentious solution. Critical winter range areas such as Churn Creek and the Junction range require co-ordinated access management plans which include road reclamation. However, new forest developments such as in the Churn Creek watershed threaten the integrity of movement corridors (P. Dielman, pers. comm.; Keystone Wildlife Research 1998).

The Backcountry Recreation Policy of British Columbia Crown Lands and Assets seeks to increase commercialized recreation of backcountry Crown lands. Development of backcountry lodges and helicopter-assisted skiing and hiking can threaten the integrity of Bighorn Sheep summer and winter ranges and movement corridors.

The regional wildlife program of habitat enhancement, which includes prescribed fire, selective logging, tree slashing, tree spacing, forage plant seeding, tree spacing, forage plant seeding, range fertilization, and noxious weed control, has been hampered by a lack of funding. Where they have been conducted, these efforts have been rarely evaluated post-treatment and thus the responses of the habitat to these treatments are largely unknown.

The Ministry of Forests also has an active program of weed control. Herbicide spraying of knapweed (*Centaurea* spp.) has been ongoing at Juniper Heights, Stoddart Creek, Mount Swansea Road, Canal Flats, Premier Ridge, and all range units within the former Cranbrook Forest District since the late 1970s. In 1994 a "weed control" project was undertaken on Juniper Heights to control leafy spurge (*Euphorbia esula*).

Under the results based code, specific regulations address ungulate winter range and mineral licks. Range use plans may address the needs of Bighorn Sheep provided careful planning and monitoring occur.

Identified Wildlife Provisions

A metapopulation approach should be used to strategically plan and manage for Bighorn Sheep with the ultimate goal of maintaining and enhancing Bighorn Sheep populations and habitats. This means developing a plan over a larger scale with adjacent jurisdictions in Alberta and Montana and in higher level planning processes using historic and current geographical distribution of Bighorn Sheep ranges and movement corridors. The Okanagan-Shuswap LRMP Approved Plan provides very complete objectives and strategies for Bighorn Sheep habitat in resource management zones as a good example of higher level planning. Additional efforts will be required such as habitat acquisition, the establishment of wildlife management areas, and reintroductions, where advisable.

Sustainable resource management and planning recommendations

The following recommendations are provided for consideration within strategic level planning processes.

- ❖ Maintain and enhance the viability of Bighorn Sheep populations and habitats over their historic range.
- ❖ Reduce and eliminate where possible the contact of other livestock with Bighorn Sheep. It is recommended that, within 16 km of known Bighorn Sheep ranges, the presence of domestic sheep and goats is avoided to minimize disease transmission and competition for forage.
- ❖ Minimize disturbance during critical times and to critical habitats.
  - Develop and implement access management plans (pre- and post-development) that include deactivation recommendations and recommendations to minimize vehicle access, habitat alienation and abandonment, disturbance to Bighorns, vulnerablility to hunters, and the spread of invasive species.
  - Avoid the use of helicopters to remove timber during critical times. Maintain a helicopter no fly zone within 2 km of key habitat features such as mineral licks and watering holes, rutting and lambing areas, and narrow migration corridors.
- ❖ Miminize recreational activities in critical Bighorn Sheep habitat particularly between April and July and between October and November.
- ❖ Maintain Bighorn access to movement corridors and critical ranges.
- ❖ Maintain Bighorn movement corridors and security or resting areas. It is recommended that these areas be buffered by a minimum of 500 m up to 2000 m.
- ❖ Maintain and enhance or restore appropriate forage species and seral stages of forests and grasslands in a condition suitable for Bighorn Sheep.
  - Maintain at least 50% of each Bighorn Sheep winter range in late seral/climax condition bunchgrass dominated communities with abundant, tall grass (easily accessible above snow cover) for winter forage.
  - In areas that have been logged, reforest at reduced stocking rates that promote understorey development (herbs, grasses, and shrubs).
  - Develop and implement prescribed burn plans to enhance forage availability or improve habitat suitability on winter ranges.
  - Limit removal of browse species by livestock to 10% or less of annual browse growth on Bighorn Sheep ranges.
  - Prevent the introduction of invasive species and control spread on ranges. Revegetation of disturbed sites in sheep habitat should be done using native species mixes.
  - Consider intensive silviculture or habitat enhancement activities (spacing and commercial thinning) to enhance important habitat features in Bighorn Sheep habitat.

Wildlife habitat area

Goals

Maintain the integrity of sensitive sites that are localized and critical for specific herds on sites (portions of ranges) where landscape prescriptions are insufficient.

Feature

Establish WHAs at critical habitats: early spring range, lambing areas, late fall rutting areas, watering holes, movement corridors, resting areas, and security sites and associated escape terrain.

Size and design

The specifics of WHA location, size, exposure, and degree of protection will vary with each herd and site specific factors. The WHA should include a core area that maintains important Bighorn Sheep habitats or habitat features and a management zone to minimize disturbance, and prevent disease transmission from domestic sheep and goats.

General wildlife measures

Goals

1. Exclude domestic sheep or goats.
2. Regulate other livestock and livestock practices especially with regards to forage competition.
3. Prevent the introduction or spread of invasive species.
4. Prevent or minimize motor vehicle access to control and prevent disturbance.
5. Prevent or minimize disturbance.
6. Maintain use and access to movement corridors and critical ranges by Bighorn Sheep.
7. Maintain important habitat features.
8. Maintain riparian vegetation and adjacent range in properly functioning condition.

Measures

Access

- Do not construct roads within core area or management zone.
- Control motor vehicle access in the core area and management zone during critical periods: 1 April to 15 July with a peak during mid-June and during October and November.

Harvesting and silviculture

- Do not harvest or salvage in the corea area except for treatments designed to maintain suitable habitat features as directed by the statutory decision maker.
- Avoid silvicultural activities in the core area during lambing or rutting periods (1 April to 15 July with a peak during mid-June and during October and November).

Pesticides

- Do not use pesticides.

Range

- Plan cattle grazing to maintain desired native shrub and grass structure, stubble height, and browse utilization in the core area.
- Control cattle grazing (timing, distribution, level of use) to prevent excess soil disturbance and the introduction of invasive species in the core area.
- Restrict cattle use in the core area between 15 April and 30 June.
- Minimize cattle use of mineral licks and watering holes in the core area. Fencing may be required by the statutory decision maker.
- Do not locate salt or mineral licks, watering troughs, or other range developments in the core area.
- Exclude domestic sheep or goats in the core area and management zone.

Recreation

- Do not develop trails, roads, or recreation sites in the core area or management zone.

Additional Management Considerations

Monitor recreational activities (e.g., ice climbing, snowmobiling) in critical Bighorn Sheep habitat and plan procedures for restricting or preventing their development or expansion.

Do not locate helicopter landing sites and backcountry recreation developments on or within 2 km of critical habitats for Bighorn Sheep.

Do not allow snowmobiles or ATVs or other motorized vehicles on critical Bighorn Sheep habitat.

Maintain a no fly zone for helicopter and fixed-wing air craft on critical habitats for Bighorn Sheep.

Maintain a 2 km distance from Bighorn Sheep for helicopters, fixed-wing aircraft, snowmobiles, and ATVs.

Restrict dogs on critical Bighorn Sheep habitat when occupied.

Prescribed burning may be necessary to maintain or enhance vegetation density.

Information Needs

1. Metapopulation conservation analysis over time to better understand the subpopulation dynamics and movement dynamics of the subpopulations in British Columbia.
2. Research on lamb survival, disease, predation, mineral sites, habitat use patterns and efficacy of habitat enhancement and impacts of human disturbance.
3. Impacts of helicopter activity.

Cross References

Badger, Burrowing Owl, "Columbian" Sharp-tailed Grouse, Flammulated Owl, Fringed Myotis, Gillett's Checkerspot, Grasshopper Sparrow, "Great Basin" Gopher Snake, Great Basin Spadefoot, Grizzly Bear, "Interior" Western Screech-Owl, Lewis's Woodpecker, Long-billed Curlew, Prairie Falcon, Racer, "Sagebrush" Brewer's Sparrow, Sage Thrasher, Sandhill Crane, Short-eared Owl, Sonora Skipper, Spotted Bat, Tiger Salamander, Western Rattlesnake, Westslope Cutthroat Trout, White-headed Woodpecker, Yellow-breasted Chat

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Caribou

Rangifer tarandus

Original prepared by Deborah Cichowski, Trevor Kinley, and Brian Churchill

Species Information

Taxonomy

Rangifer tarandus includes seven extant subspecies: Reindeer (*R. tarandus tarandus*), Wild Forest Reindeer (*R. tarandus fennicus*), and Svalbard Reindeer (*R. tarandus platyrhynchus*) in Eurasia; and Barren-ground Caribou (*R. tarandus groenlandicus*), Alaskan Caribou (*R. tarandus granti*), Peary Caribou (*R. tarandus pearyi*), and Woodland Caribou (*R. tarandus caribou*) in North America.

The Woodland Caribou includes several ecotypes, which have no formal taxonomic designation but are defined on the basis of distinct patterns of habitat use and diet/feeding behaviour. The three ecotypes described in this account are known as Mountain Caribou, Northern Caribou, and Boreal Caribou (Heard and Vagt 1998) and can be distinguished from each other by the combination of three inter-related features (Table 1).

Description

Woodland Caribou are a large, dark subspecies with short, heavy antlers (Banfield 1961) occurring in parts of boreal, cordilleran, and southeastern arctic Canada. There has been no scientific description specific to the three caribou ecotypes in British Columbia.

Distribution

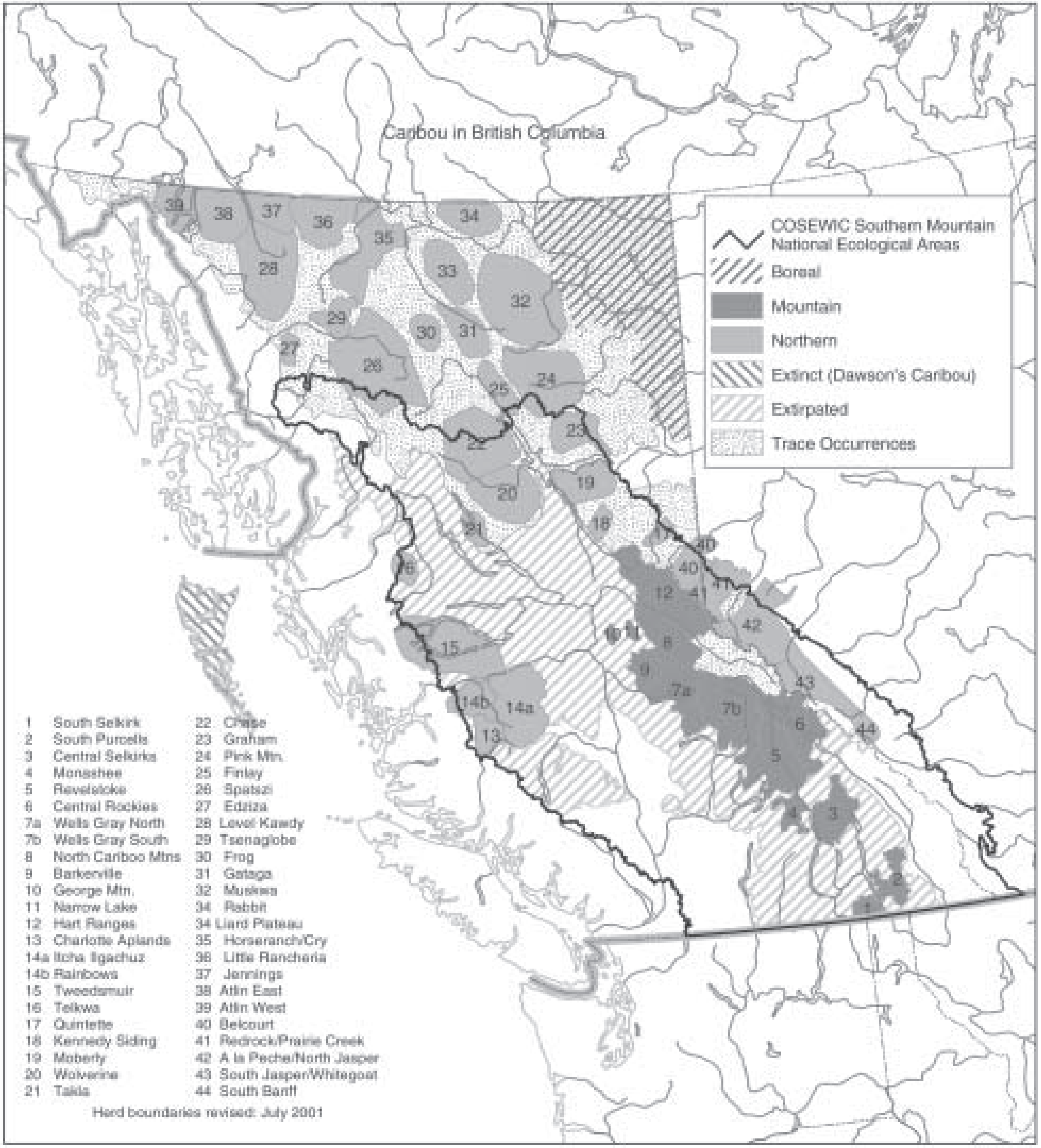
Global

Rangifer tarandus has a circumboreal distribution. In northern Europe and Asia, this species is known as Reindeer, and includes domestic, semi-domesticated, and wild populations. In North America, the species is known as Caribou and exists primarily in the wild. Extant wild subspecies in North America are:

1. Barren-ground Caribou from just south of the treeline northward in northernmost Saskatchewan and Manitoba, the Northwest

Table 1. Features of caribou ecotypes in British Columbia

Feature	Mountain Caribou	Northern Caribou	Boreal Caribou
Occurrence	Mountainous deep-snowpack portion of southeastern British Columbia known as the Interior Wet Belt	Mountainous and adjacent plateau areas with relatively low snowpacks in west-central and northern Interior British Columbia	Peatlands (muskeg) in lowland plateau portion of northeastern British Columbia, east of the Rocky Mountains, with relatively low snowpack
Winter diet	Consists almost entirely of arboreal hair lichen, with use of terrestrial lichen and other ground-based foods only in early winter	Consists mostly of terrestrial lichens with use of arboreal lichens dependent on snow conditions	Consists mostly of terrestrial lichens with some use of arboreal lichens
Seasonal movements	Generally involve little horizontal distance but strong elevational shifts	Generally involve both horizontal distance and elevational shifts	Generally involve horizontal distance but no strong elevational shifts although for some local populations, winter and summer ranges may overlap



Caribou in British Columbia
COSEWIC Southern Mountain National Ecological Areas
Boreal
Mountain
Northern
Extinct (Dawson's Caribou)
Extirpated
Trace Occurrences
1 South Selkirk
2 South Purcells
3 Central Selkirks
4 Monashee
5 Revelstoke
6 Central Rockies
7a Wells Gray North
7b Wells Gray South
8 North Cariboo Mtns
9 Barkerville
10 George Mtn.
11 Narrow Lake
12 Hart Ranges
13 Charlotte Aplands
14a Itcha Ilgachuz
14b Rainbows
15 Tweedsmuir
16 Telkwa
17 Quintette
18 Kennedy Siding
19 Moberly
20 Wolverine
21 Takla
22 Chase
23 Graham
24 Pink Mtn.
25 Finlay
26 Spatsizi
27 Edziza
28 Level Kawdy
29 Tsenaglobe
30 Frog
31 Gataga
32 Muskwa
34 Rabbit
34 Liard Plateau
35 Horseranch/Cry
36 Little Rancheria
37 Jennings
38 Atlin East
39 Atlin West
40 Belcourt
41 Redrock/Prairie Creek
42 A la Peche/North Jasper
43 South Jasper/Whitegoat
44 South Banff
Herd boundaries revised: July 2001

Territories, Nunavut, and western Greenland, totaling over 1 million;
2. Alaska Caribou in northern Yukon and much of Alaska, totalling ~1 million;
3. Peary Caribou on the Arctic islands of the Northwest Territories and western Nunavut, totalling ~2000;
4. Woodland Caribou in southern Yukon, southwestern Northwest Territories, northern, west-central and southeastern British Columbia, extreme northeastern Washington, extreme northern Idaho, west-central and northern Alberta, boreal portions of Saskatchewan and Manitoba, and the boreal and arctic portions of Ontario, Quebec, and Newfoundland and Labrador, totalling over 1 million.

Of the three Woodland Caribou ecotypes in British Columbia, Mountain Caribou occur in part of the Columbia Mountains, Idaho, and Washington, and a small portion of the west slope of the Rocky Mountains in British Columbia. Northern Caribou are found in mountainous and adjacent low elevation plateau areas in west-central British Columbia and in northern British Columbia west of and in the Rocky Mountains. Boreal Caribou are found in relatively flat boreal forests east of the Rocky Mountain in northeastern British Columbia.

British Columbia

Mountain Caribou in British Columbia occur regularly in portions of the Rocky Mountains' west slope from the Anzac River to the Morkill River, and from the Wood River drainage to the Bush Arm of Kinbasket Lake, although there are sporadic occurrences between the Morkill and Wood rivers. They also occur in the Columbia Mountains, including parts of the Cariboo Mountains, Quesnel Highlands, Shuswap Highlands, Monashee Mountains north of Whatshan Lake, Selkirk Mountains, and parts of the Purcell Mountains north of Highway 3.

Northern Caribou occur in west-central British Columbia, in and around the Itcha, Ilgachuz, Rainbow, and Trumpeter mountains as well as in and around northern Tweedsmuir Provincial Park and Entiako Provincial Park and Protected Area. They also occur in the Telkwa Mountains and around the northern part of Takla Lake. Northern Caribou are somewhat contiguous in distribution from the Williston Lake area north to the Yukon border and northwest to Atlin, and southeast along the east side of the Rocky Mountains to the Alberta border near Kakwa Park.

Boreal Caribou are found in approximately 15% of the province east of the Rocky Mountain foothills from the Yukon border east of the Liard River as far south as the Wapiti River Drainage downstream of its junction with the Red Deer River. The western boundary is indistinct but is approximately along the Liard River from the Yukon, North West Territories' boundary upstream as far as the junction with the Dunedin River, and then generally southeast to Fort St John. No caribou were likely to have or will live in the drier aspen forests along the lowlands near the Peace River although the occasional transient has been seen in these areas.

Forest regions and districts

Mountain Caribou		Northern Caribou		Boreal Caribou	
Region	**District**	**Region**	**District**	**Region**	**District**
Southern Interior	100 Mile House Arrow Boundary Central Cariboo Columbia Headwaters Kootenay Lake Okanagan Shuswap Quesnel Rocky Mountain	Southern Interior Norther Interior	Chilcotin Quesnel Fort Nelson Fort St. James Mackenzie Nadina Peace Prince Geroge Skeena Stikine Vanderhoof	Northern Interior	Peace Fort Nelson
Northern Interior	Prince George	Coast	North Island		

Ecoprovinces and ecosections

Mountain Caribou	Northern Caribou	Boreal Caribou
SBI: HAF SIM: BBT, BOV, CAM, CCM, CPK, EPM, NKM, NPK, QUH, SCM, SHH, UFT	BOP: HAP, KIP CEI: BUB, BUR, CHP, NAU, NEU, WCR, WCU COM: CRU, KIR, NAB, NAM NBM: CAR, EMR, HYH, KEM, LIP, MUF, SBP, STP, TAH, TEB, TEP, TUR, WMR SBI: BAU, ESM, HAF, MAP, MIR, PEF, SOM SIM: FRR TAP: MUP	BOP: CLH, HAP, KIP TAP: ETP, FNL, MAU, MUP, PEP, TLP

Biogeoclimatic units

ICH, ESSF, and AT occur over the majority of Mountain Caribou range and are used to varying degrees. Caribou in the northern end of the distribution (Hart Ranges, Narrow Lake, George Mountain, Barkerville, and North Cariboo Mountains local populations) use the SBS instead of or in addition to ICH. In portions of the South Purcell local population, the MS zone occurs in place of ICH, but there is very little use of the MS there.

Northern Caribou use a wide range of biogeoclimatic subzones and variants, partly because of the extent of their distribution throughout northern and west-central British Columbia. AT is used by most Northern Caribou local populations during both winter and summer. In the northern part of British Columbia, low elevation forested winter ranges occur in the BWBS zone and higher elevation ranges occur in the SWB. In north-central British Columbia, Northern Caribou low elevation winter ranges occur in SBS and BWBS, with high elevation ranges in ESSF. In west-central British Columbia, low elevation winter ranges occur in SBS, SBPS, and to some extent in the MS with high elevation ranges in the ESSF. In addition, some Northern Caribou summer range in west-central British Columbia lies within the MH at higher elevations and CWH at lower elevations.

Boreal Caribou can occur in all of the variants of the BWBS with the possible exception of the BWBSdk2.

However, the majority occur in the BWBSmw1 and BWBSmw2, which contain the wetter site series that include "peatlands" or "muskeg."

Mountain Caribou	Northern Caribou	Boreal Caribou
ESSFdk	BWBSdk1	BWBSmw1
ESSFmm	BWBSdk2	BWBSmw2
ESSFp	BWBSmw1	BWBSwk2
ESSFun[a]	BWBSwk1	BWBSwk3
ESSFvc	BWBSwk2	
ESSFvv	CWHws2	
ESSFwc	ESSFmv2	
ESSFwk	ESSFmv3	
ESSFwm	ESSFmv4	
ICHmk (limited)	ESSFwc3	
ICHmm	ESSFwk2	
ICHmw	ESSFwv	
ICHvk	ESSFwv1	
ICHwk	MHmm2	
MSdk	MSxv	
	SBPSmc	
SBSvk	SBPSmk	
SBSwk	SBPSxc	
	SBSdk	
	SBSmc2	
	SBSmc3	
	SBSmk1	
	SBSmk2	
	SBSwk2	
	SBSwk3	
	SWBmk	
	SWB (undiff)	

a A distinct subzone or variant occurs in some locations between the ESSF proper and the ESSFp, with a lower boundary where alpine larch and heathers begin (T. Braumandl, pers. comm.). This "undifferentiated" subzone has not yet been named but tentative site series for it have been identified in parts of the Kootenay region.

Broad ecosystem units

Degree of use of broad ecosystem units (BEUs) varies between local populations.

Mountain Caribou		Northern Caribou		Boreal Caribou
AH[a]	ME[c]	**AC**	**HP**	**BB**
AM	RD[c]	**AS**	**LP**	**BG**
AN[b]	RE[b,c]	**BA**	**LS**	**BL**
AT	RR	**BB**	**MI**	**BP**
AU[b]	SF[c]	**BK**	**OW**	**LP**
AV	SK	**BS**	**RD**	**LS**
EF	**SM**	**CD**	**RE**	**PR**
ER	TA[b]	**CF**	**RR**	**WL**
EW	TC[b]	**CS**	**SP**	
FP	TR[b]	**CW**	**SR**	
GL[b]	WB[c]	**FR**	**TA**	
IH	WG	**FS**	**TF**	
IS	WP[c]	**GB**	**UR**	
LL[b]		**GL**	**UV**	
LS[b]				

a Units in bold are used most consistently among local populations.
b Units used for travel or resting only.
c Units used by three or fewer local populations.

Elevation

Mountain Caribou activity is most concentrated in the upper portion of the ESSF zone, at ~1500–2100 m. However, elevation use varies by local population, year, season, and individual. Local populations occurring near the centre of current range and in areas with greater extremes of elevation tend to make more extensive use of elevations as low as 600 m for foraging, particularly in early winter and spring. Caribou in other locations are more likely to use lower elevations mainly as they cross valleys between high-elevation ranges. Sometimes elevations >2500 m are used, particularly in the summer.

Northern Caribou are found at a variety of elevations depending on season and local population. During winter, Northern Caribou are generally found either at high elevations above treeline on windswept alpine slopes or at lower elevations in forested habitat. Due to the extent of Northern Caribou range in British Columbia, lower elevation forested habitat can range from about 500 to 1500 m depending on local population. High elevation winter habitat generally ranges from 1500 m to over 2000 m. Some high elevation winter range also includes subalpine forests. During summer, Northern Caribou may be found as low as 500 m in coastal areas in west-central British Columbia to over 2500 m in mountainous areas in most local population ranges.

Boreal Caribou are found in relatively flat boreal forests in northeastern British Columbia where they occupy all elevations in that area from about 400 to 1200 m.

Life History

Diet and foraging behaviour

The late-winter diet of Mountain Caribou consists almost entirely of *Bryoria* spp., with some *Alectoria sarmentosa* and possibly *Nodobryoria oregana*. They are able to sustain themselves on this low-protein diet (*Bryoria* has only about 4% crude protein; Rominger et al. 1996), for roughly half of the year (Rominger et al. 2000). The dependence on arboreal hair lichens is probably the result of several factors. Hair lichens are usually abundant in old forests, which have historically been extensive in the interior Wet Belt, while terrestrial lichens are not. Furthermore, deep snowpacks in this region preclude cratering for most of the winter while providing lift to allow caribou to reach lichen higher in the trees. The use of forbs and graminoids increases dramatically in the spring season. Summer food consists of a wide variety of forbs, graminoids, lichens, fungi, and the leaves of some shrubs. Depending on location and year, early winter foraging may be largely restricted to the same hair lichen species as during late winter, particularly those on windthrown trees or branches, but generally also includes a variety of winter-green shrubs, forbs, graminoids, and terrestrial lichens.

During winter, Northern Caribou forage primarily by cratering through the snow for terrestrial lichens of the genera *Cladina*, *Cladonia*, *Cetraria,* and *Stereocaulon*. *Cladina* spp. are preferred but the other genera are also selected. Northern Caribou also feed on arboreal lichens opportunistically as they travel between terrestrial lichen sites or seek arboreal lichens in forested wetlands and along wetland fringes where arboreal lichens are abundant. Arboreal lichen use increases as snow hardness increases later in winter with melt/freeze conditions. During milder winters, frequent melt/freeze episodes could make cratering for terrestrial lichens difficult earlier in the winter, especially when ice crusts form close to the ground, forcing caribou to increase their reliance on arboreal lichens. *Bryoria* spp. are the most abundant arboreal lichens on most Northern Caribou winter ranges. Because of the relatively low snowpacks on most Northern Caribou winter ranges, caribou can forage on terrestrial lichens either in low elevation forested habitats, or on windswept alpine slopes. Similar to Mountain Caribou, the use of forbs and graminoids increases dramatically in the spring season and summer food consists of a wide variety of forbs, graminoids, lichens, fungi, and the leaves of some shrubs.

Less is known about Boreal Caribou foraging behaviour in British Columbia; however, Boreal Caribou, like Northern Caribou, also appear to forage primarily on terrestrial lichens and to a lesser extent on arboreal lichens during winter. Winter foraging occurs primarily in very open forests in peatlands and to a lesser extent in nearby lichen-rich pine stands where available. Presumably, summer food also consists of a wide variety vegetation.

Reproduction

The mating system of Woodland Caribou is polygynous, with dominant bulls breeding with a number of cows in late September to mid-October. Rutting group size varies between ecotype with up to a dozen for Mountain Caribou, up to 20 (or more) for Northern Caribou, and generally <5 for Boreal Caribou. Woodland Caribou in British Columbia exhibit a number of anti-predator strategies during calving including calving alone in isolated, often rugged locations (Mountain, Northern), calving on islands in lakes in low elevation forested habitat (Northern, possibly Boreal), calving in large muskegs where the number of predators and other prey are low (Boreal), and dispersing away from other caribou and prey in low elevation forested areas (Boreal) (Shoesmith and Storey 1977; Bergerud et al. 1984a; Bergerud and Page 1987).

The productivity of caribou is low compared with deer and moose because caribou only have one young per year and calves and most yearlings commonly are not pregnant. The population growth rate (l) rarely exceeds 1.26, or 26% per year. Pregnancy rate of females ranges from 90 to 97% (Seip and Cichowski 1996). Gestation is about 230 days, and calves are born in late May or early June. Calves are notably precocious, moving with their mothers shortly after birth. Calf mortality during the first few months of life is high, often 50% or greater. Causes of calf mortality may include predation, abandonment, accidents, and inclement weather. Calves generally make up 27–30% of the population at birth, but by recruitment age (1 yr old, after which mortality generally stabilizes to adult levels), their proportion is generally <20%.

Site fidelity

Fidelity patterns are complex. Some cows calve in the same location repeatedly, while others shift locations annually. Similarly, rutting sites may be occupied each year or only sporadically. Home ranges rarely remain fixed throughout an animal's life. Individual caribou typically use a predictable series of activity centres over a season or several years, but most eventually make temporary or permanent shifts to new areas. From spring through early winter, individuals may travel with several other caribou temporarily, and then shift to another band. Membership in late-winter aggregations is also inconsistent between years. At the local population level, fidelity to broad landscapes is stronger, but even at this scale there are occasional shifts of individuals and groups to areas that were not used for the past several years. Consistent use of mineral licks has been reported.

Home range

For Mountain Caribou, minimum convex polygon home ranges of 150–600 km^2 are typical, but vary from <100 to >800 km^2. For Northern Caribou, home range sizes are highly variable depending on local population size and the horizontal movement distance between summer and winter ranges. In northern and north-central British Columbia home ranges average 1100–1900 km^2 for some local populations and 150 km^2 for another (Hatler 1986; Terry and Wood 1999; Wood and Terry 1999; Poole et al. 2000). For Boreal Caribou in Alberta, home ranges averaged 710 km^2 (Stuart-Smith et al. 1997).

Movements and dispersal

Mountain Caribou

During late winter (Table 2), Mountain Caribou aggregate in open stands in or near the ESSF parkland, feeding predominantly on *Bryoria*. While there is often abundant arboreal lichen at lower elevations, the tendency to use higher elevations may result from a combination of the increased lift and support provided by a deeper snowpack, the predominance

Table 2. Approximate dates for Mountain Caribou seasons[a]

Season	Approximate dates: Stevenson et al. (2001)	Approximate dates: Simpson et al. (1997)
Late winter	mid-January – April	mid-January – mid-April
Spring	mid-April – late May	mid-April – May
Summer	June – late October	June – October
Early winter	late October – mid-January	November – mid January

a Seasonal changes are often marked by distinct elevation shifts, and actual dates vary between local-populations, individuals, and years (see Apps et al. 2001).

of *Bryoria* rather than *Alectoria*, the near absence of wolves and cougars (which typically follow the more abundant ungulates to lower elevations in the winter), and the improved ability to see remaining predators (e.g., wolverines) in the open stands typical of higher elevations. During spring, the snowpack at this elevation loses its ability to support caribou, and individuals or small groups move to either exposed sites in the upper ESSF or AT or snow-free elevations in the ICH or lower ESSF to feed on newly emerged green vegetation. In June, pregnant cows ascend individually to high, exposed locations in the ESSF or AT to calve. Such sites offer safety from most predators and relief from biting insects. During summer, caribou typically occur in small groups within the upper ESSF and AT, although there is periodic summer use of the lower ESSF in many local populations, particularly in late August or early September. From mid-September through October, Mountain Caribou beginning aggregating again for the rut. As snow accumulates in early winter, rut groups break up and most local populations shift down slope into the ICH to mid-ESSF, where snow depths are reduced due to lower elevation and greater canopy closure. Foraging at this time is variable. Arboreal lichen on windthrown trees and branches is heavily used, and caribou also crater for terrestrial lichens and winter-green forbs and shrubs such as falsebox (*Pachistima myrsinites*). As snow depth exceeds 50 cm, cratering becomes less energetically efficient and caribou move into late-winter habitat. Habitat shifts between early winter and late winter may occur as a series of events, with downward movement after major snowfalls followed by upward movement as the snow consolidates, until caribou more permanently settle into late-winter habitat in about January.

Most Mountain Caribou appear to stay within the local population in which they were born. In fact, the 13 recognized local populations may under-represent the true number of areas between which there is no to very limited movement. However, temporary movements are occasionally reported between local populations, from established local populations into unused areas, and even into the range of other ecotypes.

Northern Caribou

Although Northern Caribou are characterized by feeding primarily on terrestrial lichens during winter, local populations in British Columbia exhibit variable seasonal movement and habitat use strategies. Some local populations migrate long distances between summer and winter ranges while others do not. Use of high elevation versus low elevation winter ranges differs between local populations, and within local populations between winters. Variation in seasonal behaviour reflects differences in topography, snow accumulation, and availability of low elevation winter ranges between areas. In general, Northern Caribou habitat use in British Columbia can be described using four seasonal time periods similar to Mountain Caribou. Exact dates vary for each population depending on local conditions.

Snowfall in November triggers caribou movement out of high elevation summer ranges to lower elevation early winter ranges. Early winter ranges may be adjacent to the summer range or some distance away. At this time, caribou continue to seek out terrestrial forage and avoid deeper snow accumulations where terrestrial forages are difficult to access. Fall migration between summer and winter ranges tends to be diffuse as caribou migrate in response to snow accumulation.

During early winter, snow depth at low elevations may be highly variable between years. In general, snow depth on low elevation winter ranges is lowest during early winter and gradually increases as the winter progresses. Shallower snow depths in early winter allow caribou to use the higher and more open portions of their forested plateau winter ranges (Itcha-Ilgachuz), or low elevation forested habitats (Wolverine) that are abandoned as snow accumulates during mid- to late-winter.

By mid- and late-winter, caribou have moved to low elevation forested winter ranges, or high elevation alpine/subalpine winter ranges to feed primarily on terrestrial lichens. In low elevation forested habitat, caribou prefer forests where terrestrial lichens are abundant; these are often on drier sites or sites with low productivity and in older forests (80–250 yr). Caribou also feed on arboreal lichens opportunistically as they travel between terrestrial lichen sites or seek arboreal lichens in forested wetlands and along wetland fringes where arboreal lichens are abundant. At higher elevations, caribou prefer windswept alpine slopes for cratering for terrestrial lichens. Subalpine forests are also used for arboreal lichen feeding, and to a lesser extent, terrestrial lichen feeding.

By late April, caribou that migrate between winter and summer ranges begin moving back to calving and summering areas. Spring migration is more concentrated than fall migration both geographically and temporally. During spring, caribou migrate along relatively snow-free low elevation routes to reach summer ranges (Cichowski 1993; Johnson et al. 2002). Caribou that winter at higher elevations move to lower elevations in spring to take advantage of an earlier green-up. Spring ranges may be adjacent to late-winter ranges or may be a function of migration patterns. Female caribou reach calving areas by late May and calve in early June. Most caribou calve at higher elevations in alpine or subalpine habitat where food availability and quality is relatively poor to reduce predation risk since predators focus on other prey that remain at lower elevations where more nutritious forage is available.

During summer, caribou prefer high elevation habitats but can be found in a variety of habitats at all elevations because snow does not limit movement, and herb and shrub forage are abundant. Consequently, Northern Caribou are highly dispersed during summer, more so than during any other season. During the rut in October, some caribou move to rutting areas at higher elevations while others rut within their summer ranges. Portions of some local populations concentrate on rutting ranges, usually in open alpine or subalpine habitat.

Although studies of radio-collared Northern Caribou populations indicate that range use by adjacent local populations may overlap, especially during winter, all radio-collared caribou return to their summering areas. Northern Caribou may potentially be dispersing between local populations but no studies have yet reported any evidence of dispersal by radio-collared animals.

Boreal Caribou

Boreal Caribou do not appear to live in discrete herds but exist in small, dispersed, relatively sedentary bands throughout the year (Edmonds 1991; Heard and Vagt 1996). Although there is no specific published information on movements and habitat use by Boreal Caribou in British Columbia, studies from Alberta provide some general information that could be extrapolated to British Columbia. Boreal Caribou in northern Alberta make extensive movements or "wander" throughout the year (Hornbeck and Moyles 1995; Stuart-Smith et al. 1997) but most do not appear to make predictable seasonal migrations (Dzus 2001). Therefore, winter and summer ranges typically overlap and habitat use does not differ by season (Dzus 2001).

Habitat

Table 3 summarizes habitat characteristics of Woodland Caribou ranges in British Columbia. All habitat features are required to support Woodland Caribou populations.

Structural stage

For Mountain Caribou, structural stage 7 is consistently preferred throughout most of the year for forage, predator avoidance (typically good lines of sight and only dispersed populations of other ungulates), ease of travel, snow interception in early winter, and possibly heat avoidance in the summer (Apps and Kinley 2000a, 2000b, 2000c; Apps et al. 2001). Structural stage 6 also provides useful habitat, particularly the older and more open end of the stage. Other structural stages are used to varying degrees. Structural stage 1a and 1b are used for calving sites when occurring in rough terrain (June), predator avoidance (good line of site), insect avoidance (spring and summer), and resting areas. Structural stages 2 and 3a provide moderate to high forage value in spring and summer but also provide forage for other ungulates, especially below treeline. The least valuable stands to caribou are those in stages 3b, 4, and 5, where line of site is poor for

Table 3. General habitat requirements for Mountain Caribou, Northern Caribou, and Boreal Caribou in British Columbia

Feature	Mountain Caribou	Northern Caribou	Boreal Caribou
Winter food supply	Access to an adequate supply of accessible arboreal lichen	Access to an adequate supply of terrestrial and arboreal lichens	Access to an adequate supply of terrestrial and arboreal lichens
Snow conditions	Snow conditions that allow caribou to travel on top of the snowpack in subalpine areas where they can access arboreal lichens and where avalanche danger is low	Snow interception by forest canopy to allow movements within the winter range	Snow conditions and frozen ground conditions to allow movements through peatlands
Winter range	Large tracts of winter range where caribou can exist at low densities as an anti-predator strategy and rotate their winter ranges		
Calving habitat	Relatively undisturbed high elevation calving habitat where caribou can disperse widely and calve in isolation away from predators	Relatively undisturbed high elevation calving habitat or low elevation forested calving habitat on islands where caribou can disperse widely and calve in isolation away from predators	Large tracts of relatively undisturbed peatland complex calving habitat where caribou can disperse widely and calve in isolation away from predators

predator avoidance and forage value is generally low for caribou but can be high for other ungulates, especially moose (3b). In some cases, these stages may form partial barriers to movement and act to isolate adjacent patches of habitat from one another. Structural stage use by Northern Caribou is similar to Mountain Caribou except that Northern Caribou may forage in structural stage 5, where, in some areas and ecosystems, forage (terrestrial lichens) may be abundant. Less is known about Boreal Caribou; however, they appear to prefer structural stages 1a to 3a, 6, and 7 within muskeg complexes and 6 and 7 in adjacent pine–lichen forests throughout the year.

Important habitats and habitat features

Security and foraging

Security and foraging habitat are typically the same thing for Woodland Caribou on the forested portions of their ranges, at least at broader spatial scales. For Mountain and Northern Caribou, both functions are provided by large, contiguous patches of old forest and for Boreal Caribou, both functions are provided by the older forest component of peatland (muskeg) complexes. Specific values of such areas are as follows:

1. There are generally fewer Elk (*Cervus elaphus*), Deer (*Odocoileus* spp.) or Moose (*Alces alces*) within old-growth forests on Mountain and Northern Caribou ranges and within peatland complexes on Boreal Caribou ranges than in or near non-forested areas (avalanche tracks, meadows, shrubby riparian zones, recent clearcuts), as this more abundant suite of other ungulate species tends to concentrate in early-seral sites with abundant shrubs and forbs. Thus, the predators of other species also tend to occur less commonly within old forest than at the edge or outside of old forest or in peatland complexes. For Northern and Mountain Caribou, habitat fragmentation due to the creation of early seral patches within old forest is likely to bring other prey species close to caribou, resulting in a greater incidence of predator encounters (Kinley and Apps 2001). The potential for increased prey populations on some very dry Northern Caribou ranges may be somewhat reduced where shrub

regeneration following disturbance is less pronounced (e.g., Itcha-Ilgachuz caribou winter range). Similarly, in undisturbed areas for Boreal Caribou, habitat fragmentation due to the creation of linear disturbance and the connection of early seral patches by linear disturbances within peatland complexes is likely to provide "predator trails" and bring other prey species closer to caribou, resulting in a greater incidence of predator encounters (Dyer 1999; Kinley and Apps 2001). This pattern is consistent with that found among other caribou ecotypes, in which the major habitat variable that affects numbers is space to avoid predation (Bergerud 1980; Bergerud et al. 1984a; Bergerud 1992).

2. Old forests typically have good visibility relative to younger forests, due to open stand architecture, leading to an improved ability to detect those predators that do occur there. For Boreal Caribou, peatlands also have good visibility.
3. Arboreal hair lichen such as *Bryoria* are usually abundant only in older forests. Terrestrial lichens such as *Cladina*, *Cladonia,* and *Cetraria* are often most abundant in mature and older forests but are also abundant in younger forests on some site types.
4. Old trees with large crowns provide good snow interception, which facilitates cratering and movement during early winter (Mountain Caribou, Northern Caribou, Boreal Caribou) and winter (Northern Caribou, Boreal Caribou).
5. For Mountain and Northern Caribou, the more contiguous that foraging habitat is, the less energy is expended in moving between patches.
6. For Mountain Caribou, sunlight is screened before reaching understorey plants in old forests with heavy canopies, reducing the development of unpalatable or harmful compounds in forage plants (Rominger et al. 2000) and increasing the retention of moisture to maintain plant vigour during summer dry periods.
7. Old forests and peatland complexes provide a cooler microclimate during summer.
8. The suite of forage plants in old forest is different than that available in other habitat types.

Thus, old forests provide far more than simply lichen for late-winter foraging, and old forests are selected across seasons and a range of spatial scales. On Mountain Caribou ranges, old stands of subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*) are widely used among caribou of all local populations, including both closed-canopy and parkland stands across a range of soil moisture conditions (see "Broad ecosystem units" above). However, tree species composition shows some variability between regions. On Northern Caribou ranges, old stands of lodgepole pine (*Pinus contorta*) or lodgepole pine and white spruce (*Picea glauca*) in low elevation forested habitat are widely used by most local populations. Boreal Caribou commonly use large patches of peatland with disconnected old forest.

Mountain Caribou also use alpine habitat during summer and Northern Caribou use alpine habitat during summer and winter. Boreal Caribou do not have access to alpine habitats and therefore do not use them. Alpine habitats also provide both forage and security features. During summer, emergent vegetation provides nutritious forage and open vistas provide good visibility for detecting predators. For Northern Caribou, during winter windswept alpine slopes also provide access to terrestrial lichens and good visibility for detecting predators.

For Woodland Caribou generally, the risk of predation is further reduced by existing at very low population densities of ~0.03–0.12 caribou/km^2 (Edmonds 1988; Seip 1991; Bergerud 1992; Stuart-Smith et al. 1997). The availability of extensive range space is thought to be an important habitat characteristic that allows Woodland Caribou to avoid predation (Bergerud 1980; Bergerud et al. 1984). All three ecotypes of Woodland Caribou use "space" to avoid predation, especially during calving. Mountain and Northern caribou move into high elevation habitat, forgoing nutritious forage at lower elevations to seek out remote locations for calving, separated from other caribou and prey, and predators.

Breeding

Calving sites and rut locations are also vulnerable habitat elements, but predicting their locations by habitat type is not feasible. Calving sites are dispersed, may vary between years, and appear to be defined primarily on the basis of isolation from other caribou, other ungulates, and predators. Rutting sites are likely to be more consistent between years, but can be effectively located only with site-specific knowledge gained by monitoring individual caribou local populations.

The most critical aspect of Mountain Caribou and Northern Caribou ranges is access to undisturbed high elevation calving range. In fact, access to undisturbed high elevation calving ranges where caribou can distance themselves from other prey and predators, is the common feature among Mountain Caribou and Northern Caribou local populations that exist today. Historically occurring local populations of Mountain Caribou and Northern Caribou without access to high elevation calving ranges no longer exist in British Columbia.

Mineral licks

Another vulnerable habitat element is mineral licks. Licks are consistently used between years, but can be effectively located only by monitoring individual local populations of caribou.

Conservation and Management

Status

In British Columbia, Mountain Caribou are on the provincial *Red List*, Boreal Caribou are on the provincial *Blue List*, and Northern Caribou in the Southern Mountains National Ecological Area (SMNEA) and in the Northern Mountains National Ecological Area (NMNEA) are on the provincial *Blue List* (Table 4). In Canada, all Woodland Caribou within the entire SMNEA, including all Mountain Caribou and some Northern Caribou local populations in British Columbia, are considered *Threatened* (COSEWIC 2002). Boreal Caribou are also considered Threatened and Northern Caribou in the NMNEA are considered of *Special Concern*.

Trends

Population trends

Mountain caribou

About 99% of the world's 1900 Mountain Caribou live within British Columbia. The B.C. Ministry of Water, Land and Air Protection considers Mountain Caribou to occur as 13 local populations within a metapopulation of 1900 (Hatter et al. 2002). Six of those local populations have 50 or fewer individuals, and 8 are declining; no local populations are increasing (Table 5).

According to local population risk assessment criteria, seven local populations are considered Endangered, one local population is considered Threatened, and five local populations are considered Vulnerable. About 43% of the historic range of Mountain Caribou is no longer occupied, and it is believed that populations have been reduced correspondingly. One estimate of the pre-colonial population of Mountain Caribou (excluding the United States) is 5000–6000 (Demarchi 1999).

Northern caribou

In 2002, there were an estimated 5235 Northern Caribou within the SMNEA and 11 000 Northern Caribou within the NMNEA in British Columbia (Table 6). While numbers may have increased slightly since the late 1970s, it is likely that some of the "apparent" increase is from more intensive survey effort, combined with recent radio-telemetry studies, which has enabled a more reliable status assessment of this ecotype.

Currently, Northern Caribou in the SMNEA are distributed within 13 local populations, which form two metapopulations. The west-central metapopulation includes the Charlotte Alplands, Itcha-Ilgachuz, Rainbows, Tweedsmuir-Entiako, and status of three local populations was unknown. Four local populations have 100 or fewer animals. According to local population risk criteria, two local populations are considered Endangered, six local populations are considered Threatened, four local populations are considered Vulnerable, and one local population is considered Not At Risk. An overall increase in

Table 4. Summary of Woodland Caribou status in British Columbia

Ecotype	Status			
	Global	Provincial	COSEWIC (May 2002)	BC status
Dawson Caribou	G5TX	SX	Extinct	Extinct
Mountain Caribou	G5T2Q	S2	Threatened	Red
Northern Caribou (SMNEA)	G5T4	S3S4	Threatened	Blue
Northern Caribou (NMNEA)	G5T4	S3S4	Special Concern	Blue
Boreal Caribou	G5T?	S3	Threatened	Blue

Table 5. Current population estimate (2002), trend, risk status, and density of Mountain Caribou local populations in British Columbia

Local population	Local population estimate	Recent trend[a]	Local population risk status[b]	Risk criteria[c]	Range[d] (km^2)	Density (no./1000 km^2)
South Selkirks	35	Declining	EN	A1	1 500	23
South Purcells	20	Declining	EN	A1	2 962	7
Central Selkirks	130	Declining	EN	A3	4 813	27
Monashee	10	Declining	EN	A1	2 082	5
Revelstoke	225	Declining	VU	A1	7 863	29
Central Rockies	20	Declining	EN	A1	7 265	3
Wells Gray North	220	Declining	VU	A1	6 346	35
Wells Gray South	325	Stable	VU	A1	10 381	31
North Cariboo Mountains	350	Stable	VU	A1	5 911	59
Barkerville	50	Stable	EN	A1	2 535	20
George Mountain	5	Declining	EN	A1	441	11
Narrow Lake	65	Stable	TR	A1	431	151
Hart Ranges	450	Stable	VU	A1	10 261	44
TOTAL	1 905				62 791	30

a Recent trend defined as trend over last 7 years (1 generation length). Trend based on >20% change.

b At risk status based on Thomas and Gray (2001), draft guidelines for quantitative risk assessment of local populations. EN = Endangered; NAR = Not at Risk; TR = Threatened; VU = Vulnerable.

c Risk criteria (from Thomas and Gray 2001), see Hatter et al. (2002, Appendix 3).

d Current occupied range.

Table 6. Current population estimate (2002), trend, risk status, and density of Northern Caribou local populations in British Columbia

Local population	Population estimate	Recent trend[a]	Local population risk status[b]	Risk criteria[c]	Range[d] (km^2)	Density (no./1000 km^2)
Southern Mountains National Ecological Area						
Charlotte Alplands	50	Declining	EN	A1	2 650	19
Itcha-Ilgachuz	2 500	Increasing	NAR	A1	9 457	264
Rainbows	125	Stable	TR	A2	3 804	33
Tweedsmuir-Entiako	300	Declining	TR	A3, C3	12 811	23
Telkwa	55	Increasing	EN	A1	1 828	30
Quintette	200	Unknown	VU	A1	1 421	141
Kennedy Siding	170	Increasing	VU	A1	1 470	116
Moberly	170	Declining	TR	A2	5 115	33
Wolverine	590	Increasing	VU	A1	8 315	71
Takla	100	Unknown	TR	A1	1 850	54
Chase	575	Stable	VU	A1, A2	11 390	50
Graham	300	Declining	TR	A3	4 734	63
Belcourt	100	Unknown	TR	A1	2 045	49
TOTAL	5 235				66 890	78
Northern Mountains National Ecological Area						
Pink Mountain	850	Declining	VU	A1	11 602	73
Finlay	200	Unknown	VU	A1	3 084	65
Spatsizi	2 200	Stable	NAR	A1	16 929	130
Mount Edziza	100	Unknown	TR	A1	1 281	78
Level-Kawdy	1650	Stable	NAR	A1	12 568	131
Tsenaglode	200	Unknown	VU	A1	3 015	66
Frog	150	Unknown	VU	A1	2 421	62
Gataga	250	Unknown	VU	A1	4 437	56
Muskwa	1 250	Unknown	NAR	A1	16 786	74
Rabbit	800	Unknown	VU	A1	5 936	135
Liard Plateau	150	Stable	VU	A1	5 069	30
Horse Ranch/Cry Lake	850	Stable	VU	A1	9 499	89
Little Rancheria	1 000	Stable	NAR	A1	7 431	135
Jennings	200	Unknown	VU	A1	4 080	49
Atlin East	800	Stable	VU	A1	7 053	113
Atlin West	350	Stable	VU	A1	4 398	80
TOTAL	11 000				115 590	95

a Recent trend defined as trend over last 7 years (1 generation length). Trend based on >20% change.

b At risk status based on Thomas and Gray (2001), draft guidelines for quantitative risk assessment of local populations. EN = Endangered; NAR = Not at Risk; TR = Threatened; VU = Vulnerable.

c Risk criteria (from Thomas and Gray 2001), see Hatter et al. (2002, Appendix 3).

d Current occupied range.

Northern Caribou numbers in the SMNEA has been strongly influenced by the increase of the Itcha-Ilgachuz caribou population over the last 8 years (from 1400 to 2500; $\lambda = 1.075$), which is the largest local population in the SMNEA.

Telkwa local populations. The north-central meta-population includes the other eight local populations in the SMNEA. In 2002, four local populations were declining, two were stable, four were increasing, and the Currently, Northern Caribou in the NMNEA are distributed within 16 local populations. Meta-population structure has not yet been assessed for these local populations. In 2002, one local population was declining, seven were stable and the status of eight local populations was unknown. Six local populations have 200 or fewer animals. According to local population risk criteria, 12 local populations are considered Vulnerable and 5 local populations are considered Not At Risk. Little population information is available for many of the Northern Caribou local populations in the NMNEA.

Boreal caribou

The only estimate of Boreal Caribou numbers in British Columbia is 725 (Heard and Vagt 1996). The current estimate is based on that number (Table 7); however, the reliability of this estimate is unknown. Currently, there is no information on metapopulation structure or on population trend. According to COSEWIC criteria, Boreal Caribou in north-eastern British Columbia are considered Vulnerable.

Habitat trends

There is little quantitative information on Woodland Caribou habitat trends in British Columbia; however, Woodland Caribou rely on large tracts of older forests where terrestrial and/or arboreal lichens are abundant and where they can use "space" to avoid predators. Industrial activities such as forest harvesting and oil and gas development affect Woodland Caribou habitat through fragmentation and conversion of older forests to early seral stands. The current rate of loss and fragmentation of caribou habitat through forest harvesting, oil and gas development, and natural disturbances (fire and forest insects) appears to be greater than the rate of habitat recruitment.

Threats

Population threats

Threats to Woodland Caribou populations may affect caribou numbers directly through mortality or indirectly through disturbance or displacement resulting in increased energetic costs or mortality risks. Direct threats include predation, hunting, poaching, vehicle collisions, and diseases and parasites. Indirect threats include road development and associated traffic, persistent recreational activities on caribou ranges, and habitat alteration that results in increased mortality risks.

Table 7. Current population estimate (2002), trend, risk status, and density of Boreal Caribou in British Columbia

Local population	Population estimate	Recent trend[a]	Population risk status[b]	Risk criteria[c]	Range[d] (km^2)	Density (no./1000 km^2)
Boreal Caribou	725	Unknown	VU	A1	51 541	14

a Recent trend defined as trend over last 7 years (1 generation length). Trend based on >20% change.

b At risk status based on Thomas and Gray (2001), draft guidelines for quantitative risk assessment of local populations. EN = Endangered; NAR = Not at Risk; TR = Threatened; VU = Vulnerable.

c Risk criteria (from Thomas and Gray 2001), see Hatter et al. (2002, Appendix 3).

d Current occupied range.

Predation

Woodland Caribou populations in British Columbia exist within dynamic and complex predator–prey systems. Wolves appear to be the most significant predator, but bear predation during early summer contributes significant mortality in some areas. Recent studies (see Seip and Cichowski 1996) have found that predation during the summer can be a major cause of caribou mortality. The increase in moose populations in central British Columbia during the 1900s has been associated with long-term declines in the number of some caribou populations and extirpation of caribou from previously occupied areas (Seip and Cichowski 1996). Increased moose populations may have led to caribou declines because moose can sustain wolf numbers even when caribou number decline. In contrast, in a caribou/wolf system, wolf numbers would decline along with any decline in caribou numbers and allow for a subsequent recovery in caribou numbers (Seip 1992a). The susceptibility of caribou to predation may also be influenced by habitat change as favourable moose browsing conditions in cutblocks result in widespread distribution of moose and wolves. Disturbance to the forest (forest harvesting, fire, etc.), whether human-caused or natural, alters the distribution of early seral habitats. Such disturbance could be detrimental to caribou if it increases their contact with predators associated with other ungulates that use early seral stands, such as deer, elk, and moose. Seip (1992a) suggested that wolf predation can eliminate caribou from areas where the wolf population is sustained by other prey species because there is no negative feedback on the number of wolves as caribou numbers decline. If true, this would mean that wolves could persist on moose as they extirpate local caribou populations.

Within a multiple predator–prey system, it is possible for predator numbers to remain relatively high even if predation (or human harvest) has drastically reduced one of the prey species. Caribou are extremely vulnerable to wolf predation compared with most other ungulates (Seip 1991). Caribou usually occur at much lower densities, have larger home ranges, and do not normally use habitats frequented by moose or deer. They also do not use escape terrain as efficiently as mountain sheep or mountain goats, and they have a low reproductive rate relative to moose or mule deer. Therefore, caribou are usually the most vulnerable species in a multiple predator–prey system, the first to decline and the last to recover (Seip 1991). Seip (1992a) suggested that wolf predation can eliminate caribou from areas where the wolf population is sustained by other prey species, because there is no negative feedback on the number of wolves as caribou decline in numbers. Thus, wolves could persist on moose or deer as they extirpate local caribou populations.

Human-caused mortalities

Aboriginal people who are hunting within their traditional territories may legally hunt caribou. There are no legal hunting seasons on Mountain Caribou or Boreal Caribou in British Columbia for resident or non-resident hunters, but poaching and "mistaken identity" shootings probably remove some animals, as do motor vehicle collisions. The extent of this mortality is unknown, although Johnson (1985) found human-caused deaths in the South Selkirks Mountain Caribou local population to equal recruitment in some years. Legal hunting seasons for resident and non-resident hunters exist for most Northern Caribou local populations in the NMNEA. Hunting regulations are generally conservative with either a five-point bull, Limited Entry Hunt regulation, or a combination of both. Hunting mortality is low for most Northern Caribou local populations in the SMNEA with most of the hunter harvest concentrated in the Itcha-Ilgachuz and Chase local populations. There are no legal hunting seasons for seven of the 13 local populations in the SMNEA (Charlotte Alplands, Rainbows, Telkwa, Takla, Kennedy-Siding, Wolverine, Belcourt) and for one of the 16 local populations in the NMNEA (Mount Edziza). Parts of three Northern Caribou ranges fall within No Hunting areas or Caribou Closed areas (Atlin West, Spatsizi, Tweedsmuir-Entiako).

Diseases and parasites

There do not appear to be any diseases or parasites occurring with enough frequency among Mountain Caribou to pose a significant population-level health risk. Parasites reported by McTaggart-Cowan (1951) from caribou elsewhere in British Columbia or adjacent areas of Alberta include caribou nostril-fly or caribou bot fly (*Cephenemyia trompe* = *C. nasalis* = *Oestrus trompe*), caribou warble (*Hypoderma tarandi* = *Oestrus tarandi* = *Hypoderma tarandi*), thin-necked bladderworm (*Cysticercus tenuicollis*), the tapeworm *Cysticercus krabbei*, and pinworm (*Skrjabinema oreamni*). Other caribou parasites in British Columbia include hydatid cysts (*Echinococcus granulosus*) and the nematode *Parelaphostrongylus odocoilei* (H. Schwantje, pers. comm.). Winter ticks (*Demacentor albipictus*) have been recorded on caribou in Alberta (Samuel 1993) so likely also occur on B.C. caribou. Besnoitia (*Besnoitia tarandi*) is a protozoan that forms cysts in the connective tissue of caribou and other intermediate hosts. It can be fatal (Glover et al. 1990) but rarely is, generally resulting only in dermal damage (H. Schwantje, pers. comm.). This parasite was found in 23% of 320 caribou leg pairs examined from British Columbia, but most of the infections were from the far northern part of the province and few had skin lesions (R. Lewis, pers. comm.). Liver flukes (*Fascioloides magna*) have not been recorded from caribou in British Columbia, but occur in caribou of northern Quebec and other ungulates in British Columbia. The risk of liver flukes occurring in caribou is greater when there is overlap with elk or white-tailed deer (F. Leighton, pers. comm.), so their eventual occurrence in Mountain Caribou can be expected due to increasing range overlap with other ungulates. One of the greatest potential risks to Woodland Caribou from parasites may be the meningeal worm (*Parelaphostrongylus tenuis*) in areas where it occurs. It is a parasite of white-tailed deer throughout eastern North America. The adult worms live in the spaces around the brain in white-tailed deer and rarely cause disease. However, when other cervids, such as caribou, are infected the worms migrate to the central nervous system causing severe, usually fatal, neurological disease. Fortunately the parasite has not been found to date west of the Manitoba-Saskatchewan border.

Population size

Within the 12 smallest local populations (local populations ≤100 caribou: seven Mountain Caribou local populations, five Northern Caribou local populations), the most immediate threat is simply low population size. Low numbers increase the probability that a random event (i.e., one predator, one emigration movement, one avalanche, one extreme weather event, a few key animals poached) will remove a large proportion of the breeding population and also increase the chance of creating an unfavourable sex composition. There are no reliable estimates of the minimum viable population size for Woodland Caribou.

Access/Disturbance

One of the major indirect threats to Woodland Caribou populations is increasing road development and access into their habitat (Bergerud 1978; Johnson 1985; Seip 1991). The resulting threat may take several forms. Improved access to the summer calving range may increase risk of disturbance by humans during calving; calving areas are the most sensitive of all habitats for caribou (Seip and Cichowski 1996) and require protection. Historically, overhunting was primarily a result of road access associated with human industrial and recreational development (Bergerud 1978; Stevenson and Hatler 1985). While the more accessible Woodland Caribou populations are currently not hunted, poaching losses, which are most common along roads during hunting season for other game species, remain a concern. Road kills can also be a concern, such as those that have occurred with the opening of Highway 3 across the range of the South Selkirk Mountain Caribou local population (Johnson 1976; Simpson et al. 1994).

The effects of disturbance of human activities on caribou are more difficult to document and remain controversial. Hauling by logging trucks in Ontario apparently caused Woodland Caribou to move out of the haul road areas that were preferentially used by caribou in the years before and after hauling

(Cumming and Hyer 1998). In Alberta, simulated petroleum exploration noise was also found to increase energy expenditure by Woodland Caribou (Bradshaw et al. 1997). Physical disturbance from such exploration, such as roads, drilling sites, and seismic lines resulted in avoidance of habitats well beyond actual development "footprints" (Dyer et al. 2001).

After noting the absence of studies showing that disturbance limits caribou populations, Bergerud et al. (1984b) concluded that disturbance should not pose a major threat provided sufficient space is available for caribou to escape unwelcome stimuli. They qualified this conclusion by adding that there is likely an upper limit to the tenacity of caribou to withstand disturbance. Eight years later, Harrington and Veitch (1992) demonstrated this upper limit for Woodland Caribou in Labrador where calf survival during both calving and post-calving periods was negatively correlated to the exposure of females to low-altitude jet flyovers. This led the authors to suggest that the greatest effects of disturbance on calf survival occur during critical periods when other stressors are also acting. Research on stress effects of recreation specific to caribou requires further development; however, a recent study in Yellowstone National Park (Creel et al. 2002) documented a significant increase in stress-related hormone levels in elk and wolves during the snowmobile season. For elk, these levels increased in concert with the daily number of snowmobiles. The authors also noted that despite these stress responses, there was no evidence that current levels of snowmobile activity were affecting the population dynamics of either species.

Recreation

Studies such as Harrington and Veitch (1992) add support to a growing concern that excessive levels of recreational activity within caribou winter range may place animals under stress and displace caribou from suitable winter habitats (Stuart-Smith et al. 1996). Mountain Caribou local populations and some or portions of Northern Caribou local populations use subalpine or alpine terrain during winter. In some areas, Mountain Caribou habitat overlap snowmobile use areas; areas of heavy use by snowmobiles may displace caribou into less desirable foraging habitat and where mortality risks (i.e., predation, avalanches) are higher. The creation of trails in an area may also render caribou vulnerable to predators (James and Stuart-Smith 2000). Compacted trails such as those created by snowmobiling and snowshoeing may provide easier travel corridors for wolves into late winter caribou habitats (Bergerud 1996). Dumont (1993) found that hikers in the Gaspésie disrupted normal caribou behaviours, and shifted caribou from preferred areas on the summit to wooded areas with higher predation risk.

The increasing interest in recreational snowmobiling, combined with better access from roads to high-elevation cutblocks and more powerful machines that are able to access Woodland Caribou ranges, is believed to represent a significant threat to many Mountain Caribou local populations and some Northern Caribou local populations currently, and a significant threat to other populations in the future as access increases into their ranges. A recent review of the potential impacts of four winter backcountry recreation activities on Mountain Caribou, including snowmobiling, heli-skiing, snowcat skiing, and backcountry skiing, indicated that snowmobiling has the greatest perceived threat to Mountain Caribou (Simpson and Terry 2000). Although there is no documentation in British Columbia that snowmobiling has permanently displaced caribou off winter ranges, a single occurrence of snowmobile use in alpine habitat in the Tweedsmuir-Entiako caribou winter range displaced radio-collared caribou from that area for the duration of the winter (D. Cichowski, pers. obs.).

Industrial activities

Industrial activities may alter predator–prey relationships and potentially could increase the total predation rate of caribou by:

- producing early seral stages with enhanced understorey shrub and forb production which may increase the abundance of other ungulates or change ungulate distribution within Woodland Caribou habitat; specifically:

- increased shrub production at low elevations may increase ungulate populations (e.g., elk, deer, and moose) which in turn may increase predator populations, leading to more predator–prey encounters with caribou during winter;
- increased forb production at higher elevations may attract elk, moose, and deer into caribou habitat during summer; predators following their prey into these higher elevation areas may come into contact with caribou more frequently, leading to increased predation rates on caribou during summer;
- restricting caribou into mature forest habitat patches which may increase the search efficiency of predators; and/or
- providing easier access, through construction of roads, for predators to travel into caribou habitats and prey on caribou (James and Stuart-Smith 2000).

In addition, all threats identified below under "Habitat threats" are threats to population size and viability. There is little or no evidence that Woodland Caribou can be maintained over the long term in areas having relatively high levels of forestry, predation, and recreation activity.

Habitat threats

One of the main long-term threats to Woodland Caribou habitat is the reduction and fragmentation of contiguous old-growth forest, mainly due to industrial activities such as forest harvesting. Fragmentation of old forest and peatland complexes in Boreal Caribou habitat in northeastern British Columbia by oil and gas development is also a concern. Past fires have also contributed to the loss of habitat over large areas, and there are risks of future large fires. Forest insects are also currently playing a larger role in forest renewal on some Northern Caribou ranges. Habitat loss has several effects:

- It reduces the amount of space available for caribou, thereby limiting ecological carrying capacity.
- Terrestrial and arboreal lichen supply (although currently not limiting) may be reduced. Because lichen regeneration is often slow, impacts on lichen supply are often long term.
- It may impact caribou movement patterns.
- By fragmenting habitat, it may decrease the chance of caribou using some portions of the remaining habitat, because parcels tend to be smaller and discontinuous. Alternatively, if the remaining parcels are used, caribou may expend more energy travelling between patches.
- Caribou can become more susceptible to predation as available habitat is compressed and fragmented (see "Population threats").

Forest harvesting

Forest harvesting has been recognized as the greatest concern to Mountain Caribou habitat management over the past 20 years. Early winter habitat in the ICH has always been attractive for forest harvesting due to good forest productivity on those sites. Late winter ESSF habitat has only recently (last 10 yr) become attractive for forest harvesting. Prior to the 1970s there was little industrial activity on low productivity Northern Caribou low elevation winter ranges in British Columbia. Relatively low-value pine forests and the remote location of most of those winter ranges made them unattractive for forest harvesting. Improved road access, developments in log processing that resulted in better utilization of smaller trees, suitable sites for conducting summer logging (dry pine sites) which are often in short supply, and a growing demand for pulp contributed to increased interest in caribou winter ranges for forest harvesting.

Forest harvesting affects Woodland Caribou winter habitat at both the stand and landscape levels. At the stand level, some harvesting and silvicultural techniques disturb lichens. Because lichen regeneration is slow, forest harvesting has long-term implications for caribou winter habitat. Harvesting techniques that minimize disturbance to lichens may help reduce stand level impacts. Although food supply (lichens) is currently not a limiting factor, cumulative impacts of forest harvesting over time could potentially have long-term impacts on food supply. Caribou require an adequate supply of lichens over the landscape to allow for rotation of winter ranges. Forest fragmentation could potentially result in caribou concentrating on portions of their range, thereby depleting lichen reserves over time.

At the landscape level, forest harvesting results in a patchwork of different forest age classes, which leads to avoidance and possibly abandonment of that portion of the winter range (Smith et al. 2000). Caribou populations persist at low densities due to a number of interacting factors, including predation (Bergerud et al. 1984b; Bergerud and Page 1987). Abandoning a portion of a winter range forces caribou to concentrate in a smaller area, which may lead to increased predator efficiency by making them easier for predators to locate (Seip 1991). A patchwork of early seral and mature forests may also enhance habitat for other prey species such as moose that prefer early seral forests, which could lead to increased predator numbers and increased predation on caribou (Seip 1992a). Potential indirect effects of forest harvesting and habitat fragmentation on caribou populations through increased energetic costs and predation risk are discussed in the "Population threats" section.

Although caribou winter habitat must provide adequate amounts of terrestrial lichen, it is now recognized that food is not the primary limiting factor, and that the distribution of both the summer and winter habitats on the landscape, and the ability of caribou to become spatially separated from predators, particularly during the summer months, are the most important factors to the long-term persistence of Northern Caribou (Seip and Cichowski 1996). Forest harvesting practices that produce a patchwork of different forest age classes linked with a network of roads may contain enough lichens to support a caribou population, but probably will not provide an environment where caribou can effectively avoid predators and poachers. The threat from increasing predation may also be exerted at broader scales, independent of issues of fine-scale habitat changes. Predation risk has probably increased over roughly the past century due both to larger numbers of predators at the regional level and less spatial separation due to habitat fragmentation at the stand or landscape level. Ongoing forest harvesting by conventional means may make this situation more severe.

The ability of caribou to move through fragmented habitats or barriers is not well known. However, Smith et al. (2000) documented that Northern Caribou avoid portions of their winter range that have been fragmented by logging. Large human-caused fire-created openings 10–15 km wide have isolated the Narrow Lake and George Mountain local populations of Mountain Caribou (Simpson et al. 1997; Heard and Vagt 1998). Highways and roads may also limit caribou movements, particularly to female and young caribou moving between seasonal ranges (Simpson et al. 1994). Caribou north of Revelstoke appear unwilling to venture south of the Canadian Pacific Railway tracks and the Trans-Canada Highway, possibly due to the rail and highway corridors or to the dense, second-growth stands (Simpson et al. 1997). However, caribou appear to regularly cross Highway 16, east of Prince George, between the North Cariboo Mountains and the Hart Ranges (D. Heard, pers. comm.), and caribou elsewhere in the world make regular migrations through greatly varied habitat conditions. Even if caribou do cross fragmented habitats, there may be costs associated with increased energy expenditure required to locate isolated foraging patches, as well as increased exposure to human-caused harassment and mortality.

Although little information is available on Boreal Caribou in British Columbia, resource extraction in the form of forestry, petroleum and natural gas exploration and production, mining (coal, peat, and potentially diamonds), and agricultural expansion are all recognized as potentially having negative impacts on Boreal Caribou in Alberta (Dzus 2001).

Natural disturbances

Fire and forest insects are important disturbance factors on many Northern Caribou ranges. Fire suppression has resulted in reduced fire impacts on most woodland caribou ranges in central

British Columbia over the last 40 years, although fire disturbance has likely had greater impacts on caribou ranges in the northern part of the province. Recently, mountain pine beetles have affected a significant portion of the Tweedsmuir-Entiako Northern Caribou range. Although the effects of mountain pine beetles on caribou habitat and winter range use are not known, mountain pine beetles could potentially result in increased or decreased lichen productivity depending on site conditions. A reduction in the forest canopy and consequently snow interception could have implications to caribou movement and foraging during winter. Eventual blowdown of beetle-killed trees could also have implications for caribou movement. Larger mountain pine beetle outbreaks are often managed through increased forest harvesting efforts; extensive salvage logging also occurs soon after beetle attack. Winter ranges not located in protected areas will likely be subjected to increased forest harvesting and salvage if mountain pine beetle outbreaks occur, leading to concerns over the additive effects of mountain pine beetles, forest harvesting for mountain pine beetle management, and salvage logging of mountain pine beetle killed forests on caribou winter ranges.

Climate change

Climage change has the potential to affect Caribou habitat through changes to natural disturbance regimes and vegetation structure which may ultimately lead to changes in lichen abundance.

Legal Protection and Habitat Conservation

All Woodland Caribou in British Columbia are protected from willful killing, wounding, and taking, and legal harvesting is regulated under the provincial *Wildlife Act*. Hunting of Mountain Caribou and Boreal Caribou is prohibited while hunting for 22 of the 29 Northern Caribou local populations is currently permitted.

Protected areas, both provincial and federal, provide habitat protection from industrial activities and unroaded wilderness. Some of the larger protected areas occurring in Woodland Caribou ranges are Wells Gray Provincial Park, Glacier National Park, Tweedsmuir Provincial Park, Itcha-Ilgachuz Provincial Park, Entiako Provincial Park and Protected Area, Spatsizi Plateau Wilderness Provincial Park, Stikine River Provincial Park, and Mount Edziza Provincial Park.

Under the results based code, specific regulations address winter range and mineral licks.

Land use plans (LUP) or land and resource management plans (LRMP) have been developed for all areas where Mountain Caribou and Boreal Caribou regularly occur and for most areas where Northern Caribou occur (see Cichowski 2003). Resource management zone (RMZ) objectives from these have been or are being considered for designation as higher level plans or establishment of legal objectives under the *Land Act*.

Mountain caribou

For Mountain Caribou, each LUP or LRMP requires or allows for:

- zones where there will be no or very limited timber harvest;
- zones where modified timber harvest to maintain habitat values will occur; and
- areas with no special provisions for caribou.

However, guidelines have not been developed according to provincial standards, and the level of habitat protection varies regionally (Table 8). The great majority of recently occupied Mountain Caribou range within the Cariboo-Chilcotin Land Use Plan area is now within (in descending order) provincial parks, no-harvest zones, or modified-harvest zones and the Mountain Caribou Strategy provides specific and detailed guidance on silvicultural systems (Youds et al. 2000). The Prince George and Robson Valley LRMPs have included most of the caribou habitat within interim deferral areas and to a lesser degree, in parks. The Kamloops LRMP area is immediately adjacent to Wells Gray Provincial Park so caribou there have habitat security within Wells Gray and a few new parks, and 20–33% of the caribou zone outside of parks is to be maintained

Table 8. Current approaches to Mountain Caribou habitat management within LRMPs and LUPs

LRMP/LUP	Approach
Cariboo-Chilcotin	No-harvest and modified-harvest zones, each of which is mapped.
Kootenay-Boundary	No-harvest and modified-harvest zones conceptual only. Overall management areas are mapped, but precise locations of zones are not (in progress).
Prince George	No-harvest and modified-harvest zones, each of which is mapped (but no-harvest zones may become available for modified harvest, pending results in areas now designated for modified harvest).
Robson Valley	No-harvest and modified-harvest zones, each of which is mapped (but no-harvest zones may become available for modified harvest, pending results in areas now designated for modified harvest).
Kamloops	Similar to Kootenay/Boundary but based on the retention of old-growth attributes, not old-growth forests per se, and partial cutting is preferred but not required in non-reserve areas.
Okanagan-Shuswap	Identifies OGMAs to be maintained as reserves and also identifies research areas, which may later become reserves, conventional harvest areas, or modified-harvest areas, pending research results.

with old-growth attributes. The Okanagan-Shuswap LRMP allots approximately 20% of the caribou resource management zone to Old-Growth Management Areas (OGMAs) and about 3% to new or existing parks, with a further 20% deferred as research areas. The Kootenay-Boundary Land Use Plan allocates 40–50% of the operable portion of caribou management areas for reserves or modified harvest, and perhaps 10% of the total occupied caribou range is in new or existing provincial and federal parks.

Mountain Caribou have been a major consideration in the designation of OGMAs, but these often overlap with lands that were already, or would otherwise have been, reserved for caribou, so generally do not add additional protection. In the Okanagan-Shuswap LRMP, all permanent caribou reserves are OGMAs. Areas that are currently considered inoperable provide additional habitat for each local population of caribou, but the extent of these is likely to be reduced as technological or economic conditions change.

Access management approaches and (for most plans) guidelines for alternative silvicultural systems are less specific than habitat protection guidelines and are typically not included in higher level plans. Local decisions on alternative silviculture will presumably be guided mainly by the recommendations for managers guidebook (Stevenson et al. 2001). Interim guidelines for access and disturbance management relative to new commercial recreation tenures have been developed (MELP 2000).

A recovery strategy for the entire Mountain Caribou metapopulation has recently been completed (Hatter et al. 2002) and a recovery action plan specific to the South Purcell local population is currently being developed (Kinley 2000). Plans for other local populations may be developed in the future as determined by Regional Action Groups (Hatter et al. 2002). The recovery strategy and proposed recovery action plan for the South Purcell local population do not create any additional legal obligations. However, they do indicate an intent to maintain Mountain Caribou, consistent with the federal-provincial National Accord for the Protection of Species at Risk, and will provide a benchmark from which to measure regional and sub-regional management plans. Several factors influencing caribou population viability that do not fall within the results based code or do so only partially are addressed in recovery plans, including population goals for predators and alternate prey species, and motorized recreation management.

Northern caribou

Current strategies to protect local populations of Northern Caribou and habitat have been mostly developed independently for each population and are reflected in regional land and resource management plans (Chicowski 2003). Although there is no province-wide strategy that guides management direction for all local populations of Northern Caribou, planning efforts have often been co-ordinated between land use planning processes that share a common caribou winter range. However, core caribou ranges for some local populations, and corridor/linkage areas between local populations still must be mapped and considered in various plans.

Some form of caribou habitat management guideline(s) or planning/operational direction is in place in most MWLAP regions that support Northern Caribou. Currently, an LRMP process is underway for the Morice Forest District which includes portions of three Northern Caribou local populations in the SMNEA (Tweedsmuir-Entiako, Telkwa, Takla) and a Strategic Resource Management Plan is being developed for the Dease/Liard portion of the Bulkley-Cassiar Forest District. Only two areas remain without regional level management plans: the Nass portion of the Kalum Forest District, which includes a small portion of the Spatsizi caribou local population's range; and the Atlin-Taku region of the Bulkley-Cassiar Forest District, which includes four local populations (Atlin West, Atlin East, Jennings, Level-Kawdy).

Prescriptions vary by planning area and local populations of caribou although communication between planning processes has resulted in mostly consistent prescriptions for local populations of caribou whose ranges straddle planning areas. Most plans consist of a combination of protected area or no-harvest zone in portions of each caribou range, with varying degrees of industrial activity within the rest of the range. Although unprotected portions of most caribou ranges have some special management status, large portions of some ranges are located in general resource management zones or even enhanced resource management zones.

In most of the land use plans, caribou and caribou habitat management are a high priority. District-wide Caribou Management Strategies were developed in the Mackenzie, Cassiar-Iskut-Stikine, and Fort St. James LRMPs. In the Lakes, Vanderhoof, and Bulkley LRMPs, caribou management strategies are concentrated within resource management zones that encompass most of the caribou range found in those districts. The Cariboo-Chilcotin Land Use Plan also defines a regional level Northern Caribou Strategy, that provides specific direction on all aspects of caribou management including mountain pine beetle infestations (Youds et al. 2002). The Dawson Creek, Fort St. John, Fort Nelson, and Prince George LRMPs do not contain specific district wide strategies for managing caribou and caribou habitat; instead, caribou management guidelines have been developed for individual resource management zones. However, portions of the Fort St. John, Fort Nelson, and Mackenzie LRMP areas are included within the Muskwa-Kechika Management Area, which includes special provisions for access management and resource extraction. Many of the protected areas established under the *Environmental Land Use Act* within the Muskwa-Kechika Management Area contain provisions for road corridors and most of the area outside of protected areas is under special management.

Although large-scale mountain pine beetle outbreaks have occurred or may potentially occur in most caribou winter ranges in the central part of the province, most of the land use plans provide little guidance for mountain pine beetle management on caribou winter ranges. Potential additive effects of mountain pine beetles, mountain pine beetle management, and salvage logging are of concern.

In general, most Northern Caribou management prescriptions in these plans focus on:

- avoiding critical habitats through no harvesting or special management;
- providing large contiguous areas of mature and old forest;
- conducting harvesting strategies that emulate natural disturbances;

- maintaining forest structure and age classes close to natural disturbance patterns;
- creating large forest harvesting openings and concentrating them in time and space to minimize industrial activity on caribou ranges;
- using forest harvesting and silvicultural systems that enhance retention and recovery of terrestrial lichens; and,
- developing recreation and access management strategies that limit or prohibit recreational activities and access in specific areas during critical seasons.

Boreal caribou

Boreal Caribou range in British Columbia falls within two forest districts with completed LRMPs: the Fort Nelson LRMP and the Fort St. John LRMP. There are no district-wide caribou management strategies and strategies for Boreal Caribou are primarily contained in individual resource management zones. In the Fort Nelson LRMP, most of the Boreal Caribou range is in enhanced resource development zones with the southwestern portion in general resource development zones; provisions for caribou are included under general provisions for wildlife. In the Fort St. John LRMP, most of the Boreal Caribou range is in general management zones with a small portion in enhanced resource development, and the southern portion in the agriculture/settlement zone. Provisions for caribou vary between resource management zones with some zones with caribou-specific provisions and others with general wildlife provisions. Lack of management strategies specifically for Boreal Caribou is likely partially due to the lack of knowledge about this ecotype in British Columbia.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

A conservation assessment should be conducted for Woodland Caribou metapopulations to determine the relative risk to long-term persistence of each metapopulation and ecotype based on current management guidelines, and also on a range of potentially more or less stringent guidelines.

LRMPs and LUPs provide a suitable scale of management for Woodland Caribou because individual caribou are wide-ranging and use a variety of sites within and between years, yet each local population occurs within a reasonably well-defined geographic and habitat range. Furthermore, regional differences in Woodland Caribou ecology and in forest harvesting history indicate that detailed management direction is best provided through a series of regional plans than through a single provincial plan. However, broad approaches are best standardized at a provincial scale to ensure better understanding of the purpose of areas given special designation for caribou, and to ensure that all regional plans meet the basic requirements of Woodland Caribou. The following recommendations should be considered when existing higher level plans are periodically reviewed and revised.

- ❖ Conduct local conservation assessments (including risk assessments) for the local population or area under consideration. The assessment should consider risks to the individual local population and the metapopulation based on current guidelines, and therefore determine the relative need for no-harvest relative to modified-harvest and conventional-harvest zones, and effects of resource exploration activities.
- ❖ Identify areas that should be designated as no-harvest zones, where there will be no or very limited harvest, and/or modified-harvest zones, where partial cutting that maintains habitat values may occur. Within the no-harvest zones, include inoperable areas that are suitable for caribou, in addition to appropriate operable areas.
- ❖ Map the final boundaries of no-harvest zones or modified-harvest zones at 1:20 000.
- ❖ For Mountain Caribou, where plans currently advocate or permit the use of extended-rotation clearcuts (typically 240 yr), either via conventional blocks or strip harvesting, consider a shift to a mix of permanent no-harvest zones and conventional harvest (no caribou constraint) zones, and formalize this as an option in the plans. The percentage of the plan area potentially shifted from long-rotation to no-harvest should

be calculated on the basis of modelling long-term timber production reductions that would otherwise result from the extended rotation. The advantages of smaller permanent no-harvest zones versus larger areas on extended rotations would be:

- no new economic impact relative to existing extended rotation assumptions, yet retention of a large portion of the planning area as caribou habitat;
- a greater assurance that designated habitat would in fact provide suitable habitat because it would be of natural origin and older age, rather than originating as a plantation with a maximum age of 160–240 years;
- fewer roads and off-road access points;
- long-term spatial certainty regarding the areas that would provide caribou habitat, which would simplify planning and allow caribou to develop traditions of use; and
- overlapping of benefits to other obligates of very old forests.

The disadvantage is that less gross area would be managed for caribou. This option should also be considered in cases where long-rotation group- or single-tree selection is currently planned, although there are likely to be fewer benefits in changing to the mixed no-harvest/conventional harvest scenario in such instances. For plans that currently recommend the use of clearcut harvesting with moderate block sizes (~1–40 ha), consider a shift to guidelines requiring partial cutting through single-tree selection or group selection or, as a secondary option, a mix of very large cutblocks and very large reserves as outlined in Stevenson et al. (2001). This will reduce the degree of landscape fragmentation relative to an equivalent area of moderate-sized clearcut blocks, and should therefore reduce the enhancement of habitat for other ungulates and allow caribou to separate themselves from predators.

❖ For plans in which habitat-influenced predation risk is not explicitly identified as an issue relative to forest harvesting, it should be added to revised versions of the plans.

❖ Revise existing guidelines for movement routes based on new research. Add guidelines to plans currently lacking them. As research indicates differences in habitat requirements for providing long-term genetic connectivity between local populations versus regular local intra- or interseasonal movement, modify plans to ensure that the terminology and guidelines are appropriate for the type of movement intended to be facilitated.

❖ Revise access management guidelines based on new research. Add access guidelines to plans currently lacking them. Do not create new roads or upgrade existing roads in areas where forests have been reserved as caribou habitat. To the extent possible, deactivate or close existing roads in areas reserved or managed for caribou when the roads are no longer required for industrial activities. Guidelines for the management of both commercial and non-commercial mechanized backcountry recreation should be adopted, based on the interim management guidelines recommended by Simpson and Terry (2000).

❖ Ensure a mechanism is included to allow the boundaries or locations of no-harvest and modified-harvest zones to be modified as additional information becomes available about caribou distribution, habitat use, risks associated with various management options, and requirements for long-term viability. This mechanism should also allow boundary changes necessary for the recovery of currently depressed local populations, including augmentation with additional animals or the establishment of new bands of caribou.

Wildlife habitat area

Goal

To temporarily secure critical Woodland Caribou habitat features that have not been yet been addressed through strategic or landscape level planning. As existing plans are amended or developed, WHAs established for Woodland Caribou should be considered for inclusion within legal objectives of the revised plans or new plans.

Feature

Establish WHAs at mineral licks, rutting or calving sites (if used repeatedly), and small areas of "matrix" habitat necessary for connectivity between winter foraging areas (if used repeatedly). Preferably, WHAs should be established in areas of suitable caribou habitat where:

- no-harvest zones and modified-harvest zones are not sufficiently large to maintain or restore viable caribou local populations as indicated by a conservation assessment; or
- there is a high level of uncertainty that this is the case; or
- critical habitat features not addressed within an existing regional or sub-regional plans are determined to be of high value or high use.

WHAs designated under the provincial timber supply impact limit (1% by district) for the Identified Wildlife Management Strategy will only be established within threatened or endangered local populations, except for sites where there is no timber supply impact or the site is considered provincially significant and approved by the Director of the Biodiversity Branch, B.C. Ministry of Water, Land and Air Protection. Normally, WHAs will only be established to protect critical habitat features deemed important to the long-term persistence of the local population.

For matrix habitat connectivity, WHAs should be located immediately adjacent to protected areas or areas designated under strategic land use plans for caribou management.

Size

Larger WHAs will almost always be of greater benefit to caribou than smaller WHAs, primarily because increased size improves the ability of caribou to avoid predation. When WHAs are established in matrix habitat for connectivity, they should be roughly 100–1000 ha. In most cases, calving sites, rutting areas, and mineral licks may be adequately managed in areas of 50–300 ha. For calving sites on islands, the entire island should be considered for inclusion within a WHA. The appropriate size for a WHA will be determined in part by whether it is possible to link to existing habitat and the degree of disturbance that is expected adjacent to the WHA.

Design

Design WHA to minimize the amount of edge, and consider habitat use and the needs of the local population. The size of the area included within the WHA to reduce disturbance will depend on topographic barriers and vegetative cover.

General wildlife measures

Goals

1. Minimize predation risk.
2. Maintain critical habitat features (e.g., mineral lick, undisturbed travel corridor or calving or rutting areas).
3. Minimize disturbance.

Measures

Access

- Do not construct roads or trails.

Harvesting and silviculture

- Do not harvest WHAs established for mineral licks, rutting, and calving sites. For matrix habitat, develop a management plan that is consistent with the general wildlife measures goals.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreation sites or trails.

Additional Management Considerations

Guidelines for the management of both commercial and non-commercial mechanized backcountry recreation should be adopted, based on the interim management guidelines recommended by Simpson and Terry (2000). (See MWLAP Web site at http://wlapwww.gov.bc.ca.)

In addition to reducing the effect of predation through forest management that minimizes fragmentation and habitat creation for other ungulates, large mammal species should be managed with the goal of locally reducing the number of other ungulates and associated predators, where such species were historically rare or absent.

If motor vehicle collisions (Highways 3, 5, and 16, Alaska Highway) are identified as a significant source of mortality in some local populations, and kill locations and timing are consistent, seasonal speed zones should be instituted.

Information Needs

1. Metapopulation conservation assessment/risk analysis relative to a range of management options.
2. Long-term suitability of areas cut through modified harvest to support caribou, with reference to both forage and predation risk.
3. Relative contribution to predation of regional increases in alternate prey numbers versus stand level or landscape level habitat fragmentation.

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Plant Communities

Antelope-brush/Bluebunch Wheatgrass

Purshia tridentata/Pseudoroegneria spicata

Original prepared by W.R. Erickson

Plant Community Information

Description

This dry shrub-steppe grassland community is rare in late seral stages with a natural fire cycle (CDC n.d.). These remnant stands of antelope-brush (*Purshia tridentata*) and bluebunch wheatgrass (*Pseudoroegneria spicata*) are often found on crests and upper slopes. Sites are also sometimes in open, savannah settings of ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*). Saskatoon (*Amelanchier alnifolia*), Idaho fescue (*Festuca idahoensis*), and arrow-leaved balsamroot (*Balsamorhiza sagittata*) are also key species. These sites have a diverse herbaceous flora (Braumandl and Curran [compilers and editors] 1992).

Rough fescue (*Festuca campestris*) or kinnickinnick (*Arctostaphylos uva-ursi*) are also dominant on some sites, and others may have shared abundance or patches of Columbia needlegrass (*Achnatherum nelsonii*), Sandberg's bluegrass (*Poa secunda*), pasture sage (*Artemisia frigida*), and shining arnica (*Arnica fulgens*). The presence of hairy golden-aster (*Heterotheca villosa*) and stiff needlegrass (*Achnatherum occidentalis* ssp. *pubescens*) are considered diagnostic.

Other herbs typically present with a low cover include junegrass (*Koeleria macrantha*), slender hawksbeard (*Crepis atribarba*), timber milkvetch (*Astragalus miser*), yarrow (*Achillea millefolium*), death camas (*Zigadenus venenosus*), old man's whiskers (*Geum triflorum*), graceful cinquefoil (*Potentilla gracilis*), fern-leaved desert parsley (*Lomatium triternatum*), brown-eyed Susan (*Gaillardia aristata*), tufted phlox (*Phlox caespitose*), mariposa lily (*Calochortus macrocarpus*), dwarf goldenrod (*Solidago spathulata*); and both blue-eyed Mary (*Collinsia parviflora*) and prairie crocus (*Anemone patens*) in spring.

Generally there is no moss and lichen layer. Occasionally, sites have a high cover of lichens (*Cladonia* spp.) or mosses (*Tortula ruralis*).

The presence of Kentucky bluegrass (*Poa pratensis*), particularly where it occurs with higher cover, is an indication of higher disturbance levels.

Climatically, this plant community occurs within relatively hot dry regions for plant growth. This community occurs on coarse-textured, glacio-fluvial terraces or colluvial materials over calcareous bedrock. Three common slope position occurrences are level, valley bottom sites; warm aspect, upper slopes (10–40%); to crests. These sites have been assigned to xeric moisture and medium to rich nutrient classes (Braumandl and Curran [compilers and editors] 1992). Soils vary from sandy and poor on the terraces to loamy and very rich on the slopes. They are classified variously, but melanization is a major soil process. Humus forms are usually Rhizomulls, but may be less well developed (Moders or Mors) on poor sites.

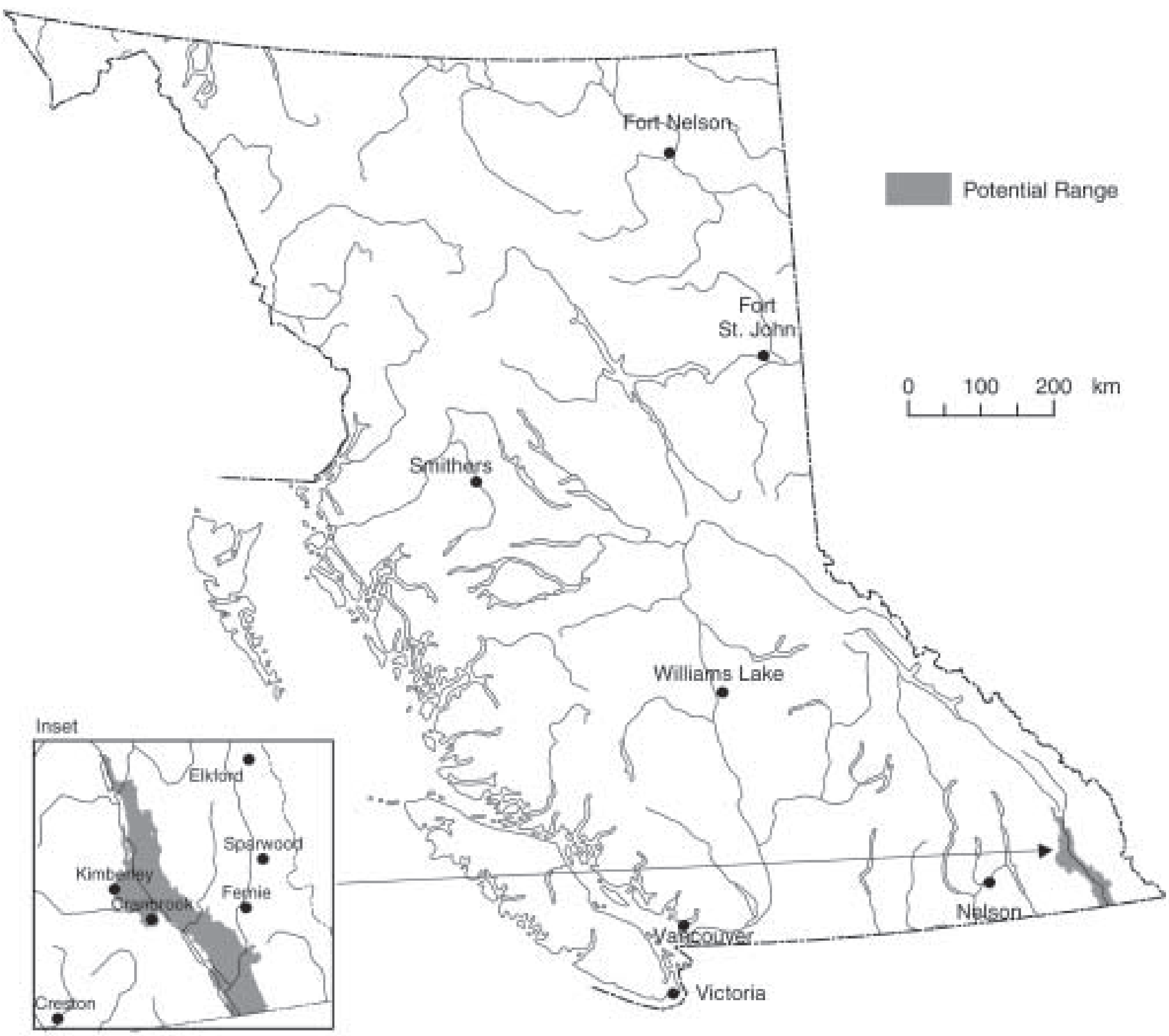
Distribution

Global

The community is one of a complex of similar types that reaches its northern extent in British Columbia. Occurring east of the Cascade Mountains in British Columbia, similar plant communities extend south to Washington and Oregon, Idaho and Montana, and Oregon (NatureServe Explorer 2002).

Antelope-brush / Bluebunch Wheatgrass

(Purshia tridentata / Pseudoroegneria spicata)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

British Columbia

This plant community is restricted to valley bottoms and lower slopes in the southern Rocky Mountain Trench. It occurs south of Canal Flats, is bounded on the west by St Mary River and on the east by Baynes Lake, and extends to the border at Tobacco Plains.

Forest region and districts

Southern Interior: Rocky Mountain

Ecoprovince and ecosection

SIM: EKT

Biogeoclimatic units

IDF: dm2/02

PP: dh2/00

Broad ecosystem units

DP, PP

Elevation

700–1200 m

Plant Community Characteristics

Structural stage

3: shrub-herb

3a: low shrub

Sometimes set in open savannahs not covered by the structural stage classification.

Natural disturbance regime

Frequent stand-maintaining fires (NDT4) (MOF and MELP 1995). Periodic fire, grazing and browsing, and insect outbreaks are among the historic natural disturbances for this community (Youtie et al. 1988; MOF and MELP 1995; Rondeau 2001; University of Wyoming, n.d.; D. Johnson, pers. comm.). Collectively, these disturbances would keep stands open and provide renewal or replacement opportunities where growth or vigour was stagnated due to plant density, bunchgrass litter, pine needle accumulations, or competition. Renewal would be provided by a frequent fire regime, such as the 5- to 25-year frequency required to maintain the ponderosa pine/antelope-brush habitat type, bluebunch wheatgrass phase in a treeless state (Arno 1979; Fischer and Clayton 1983).

This community is part of broader fire-maintained ecosystems, which have been subject to fire suppression and consequent forest encroachment and ingrowth (Gayton 1996; Hardy and Arno [editors] 1996). In addition, the key species of the community still have susceptibilities to higher burn intensities in different seasons (Thomson 1988; Zlatnik 1999a, 1999b).

The species of this community are generally adapted to and resilient to disturbance. An exception is the susceptibility of bluebunch wheatgrass and Idaho fescue to spring defoliation by herbivores (McLean and Marchand 1968). Conditioning of the vegetation by native ungulates is part of the natural ecosystem processes of this community. The subzone variant area supports large populations of ungulates and is important as winter range. Current typical composition reflects the influence of grazing and browsing pressure, with more dominance by antelope-brush and balsamroot, and less by Idaho fescue and bluebunch wheatgrass (Youtie et al. 1988; University of Saskatchewan, n.d.; pers. obs.). In addition, these latter two bunchgrasses most likely have exchanged dominance on late seral sites. This community has been replaced by grazing pressure on early seral sites, with conversion to pussytoe species, needlegrasses and weedy forbs, and invading species such as cheatgrass (McLean and Marchand 1968; pers. obs.). Sometimes, however, the tough, arching stems of bitterbrush provide mini-refugia, which protect the late-seral species (D. Gayton, pers. comm.).

For the most part, the form of antelope-brush differs when compared with shrubs in the south Okanagan valley (W. Erickson, pers. obs.). The smaller and less-upright form and presumably younger top-growth may suggest historic disturbances, more severe winter temperatures, effects or possibly a genetic difference in the Trench populations (pers. obs.; D. Gayton, pers. comm.). A negative feedback mechanism should be noted, in which the old growth antelope-brush plants are killed in the event of a fire, due to the level of fuel accumulation in their structure and in the protective zone they provide (D. Gayton, pers. comm.).

Many sites currently have considerable exposure of bare mineral soil. The extent to which this represents the natural condition (i.e., due to natural erosion or hoof action by native ungulates) is unknown.

Fragility

Moderately fragile due to the dry climate and the effects of coarse soils on plant growth, ameliorated by the presence of underlying calcareous bedrock and the site stability influences of the coarse soils. Classic studies by McLean and Marchand (1968) in related habitats indicate the long period of recovery required from an early seral stage. Many sites may be stalled in a state with Kentucky bluegrass, needlegrass (*Achnatherum* spp.), or cheatgrass (*Bromus tectorum*) dominance, and may require management treatments for recovery (Westoby et al. 1989).

Conservation and Management

Status

The antelope-brush/bluebunch wheatgrass plant community is on the provincial *Red List* in British Columbia. It is ranked S2 in British Columbia. Its global status is unknown; however, related plant communities are ranked G3.

Trends

Identified as declining, with remaining occurrences estimated at between 21 and 100 (Meidinger et al. 2002). The plant community has been replaced with weedy, seral species on many sites, and some sites have been lost to development. There is not a complete inventory of occurrences of this plant community, but at least 17 plots have been described (Meidinger 2002; W. Erickson, unpubl.). Terrestrial ecosystem mapping summaries indicate 710 ha mapped as this community in the Premier-Diorite project area. Based on plot data from the project, there is considerable disturbance and invasion of introduced species in the area.

Threats

Threats include livestock and wildlife grazing and browsing, urban development, invasive species, impoundments, golf course development, intensive agriculture and probably climate change. In addition, fire suppression, soil exposure, reductions in plant cover, and the lack of prescribed burning lead to forest encroachment. Outdoor recreation (e.g., trail bikes), livestock and wildlife grazing and browsing can cause soil exposure, impact plant vigour and composition, and reduce ecosystem stability. Invasive species can invade the community, displacing native plant species.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those within protected areas and parks.

This community occurs in several small protected areas, including Kikomun Creek Park, Premier Ridge and Sheep Mountain Wildlife management areas. It may also occur within Premier Lake Provincial Park and recently acquired conservation properties.

Several range reference areas include this community, including Skookumchuck, Old Premier Ridge, Gold Creek, Bagley's Pasture, and Bull River. Others, such as Premier Ridge, Pickering Hills, and Standard Hill, are currently in earlier seral stages, but have the site potential to develop this community over time. These long-term monitoring exclosures are considered too small in size (2–3 ha) for plant community conservation, with the exception of Skookumchuck, which has 104 ha under protection (D. Gayton, pers. comm.).

The *Forest and Range Practices Act* enables the use of range use plans in managing livestock operations. Range use planning may address this community through implementation of similar recommendations as outlined below in the "General wildlife measures" below.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

This small patch community was originally distributed over ~385 000 ha, although sparsely. It occurred as small to large patches, often within a mosaic of open or savannah type forest, and grasslands. It is recommended to:

- ❖ maintain and restore shrub-steppe grassland and open savannah;
- ❖ control forest ingrowth and encroachment;
- ❖ maintain or restore at least 20 occurrences of this community in good condition across the range of the plant community; and
- ❖ maintain or restore occurrences to as close to natural condition as possible and practical.

Wildlife habitat area

Goal

Maintain or recover known occurrences.

Feature

Establish WHAs at occurrences that have been confirmed by a registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologists. Priority for WHAs should be any climax occurrences of this community. As a lower priority, WHAs may be established within earlier seral stages where the key species of the community are present in small patches, to recover community to climax condition.

Size

The size of the WHA should be based on the extent of the plant community occurrence. WHAs will generally be between 5 and 20 ha when the community occurs in relatively pure composition. However, WHAs may be larger, when the community has a patchy distribution or when recovery is the main objective.

Design

The WHA should encompass the entire extent of the occurrence plus a 100 m surrounding the perimeter of the community. When occurrences are narrow, such as along ridge tops, include 200 m surrounding perimeter. Where possible, minimize inclusion of invasive species.

General wildlife measures

Goals

1. Maintain and restore antelope-brush, bluebunch wheatgrass, Idaho fescue, rough fescue, and balsamroot cover; cycles of litter and light intensity natural fire renewal. Increase cover and diversity of other native species (e.g., forbs, rough fescue) and maintain open savannah structure (e.g., <15% cover) of older (e.g., >150 year old) ponderosa pine and Douglas-fir trees where they are present.
2. The recommended Desired Plant Community is as follows: shrub-steppe between 15 and 30% canopy cover of antelope-brush; herb layer dominated by >5%, preferably >15% cover each, of at least two of the following: bluebunch wheatgrass, Idaho fescue, rough fescue, or arrow-leaved balsamroot. A composition with <10% each of co-dominating saskatoon, pinegrass, or other herb layer species is acceptable.
3. Manage to maintain and increase the species named above as the Desired Plant Community.
4. Maintain a diversity of disturbance regimes.
5. Allow for the processes of litter accumulation and renewal.
6. Maintain a diversity of understorey species composition (e.g., *Festuca* spp.).
7. Maintain shrub-steppe/grassland structure and plant community processes.
8. Minimize soil disturbance.
9. Control forest encroachment and ingrowth.
10. Minimize the introduction and spread of invasive species.

Measures

Access

- Do not develop roads or trails.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing (i.e., timing, distribution, and level of use) to meet general wildlife measure goals described above. Fencing could be required by the statutory decision maker to meet goals, to recover community, or for restoration treatments.
- Do not place livestock attractants within WHA.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation, soils, and hydrology when operating adjacent to a WHA, particularly during road development and maintenance.

Actively manage to restore and maintain this community, emulating effects of natural fire regime, with restoration silvicultural treatments and light intensity, prescribed burns in fall (Thomson 1988; Zlatnik 1999a, 1999b). Burns should be able to be carried out under a regular burn plan, plus species-level monitoring, without the need for a specific site management plan. Light to moderate grazing/browsing and periodic renewal are necessary as part of the disturbance regime for this community, but higher levels can cause the loss of the community through competition-mediated shifts in composition and species invasions (McLean and Marchand 1968; Ross 1997).

Avoid linear or extensive soil disturbances. Concerns around access are based on the concentrating effect of livestock or wildlife use, which can increase the spread of invasive species (e.g., cheatgrass).

Restrict recreational use (i.e., dirt bikes, mountain bikes, and other off-road vehicles).

Private land stewardship will be an important component of the conservation of this community as many sites occur on private land.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Monitor recovery trends in relation to site factors and restorations treatments, and for the relationship between specific community types currently encompassed within this community.

Cross References

Badger, Douglas-fir/snowberry/balsamroot, Lewis's Woodpecker, Long-Billed Curlew

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Antelope-brush/Needle-and-thread Grass

Purshia tridentata/Hesperostipa comata

Original prepared by T. Lea, S. Flynn, and C. Cadrin

Plant Community Information

Description

This shrub-steppe community has a shrub layer consisting of antelope-brush (*Purshia tridentata*), with lesser amounts of big sagebrush (*Artemisia tridentata*) and rabbit-brush (*Ericameria nauseosus*). The herb layer is dominated by needle-and-thread grass (*Hesperostipa comata*), with brittle prickly-pear cactus (*Opuntia fragilis*), red three-awn (*Aristida purpurea* var. *longiseta*), and sand dropseed (*Sporobolus cryptandrus*). The moss layer may contain a low percent cover of *Tortula ruralis*. This community at climax is expected to have a moderate cover of bluebunch wheatgrass (*Pseudoroegneria spicata*) and junegrass (*Koeleria macrantha*) (Lea and Maxwell 1995). The cryptogam crust at climax should consist of a variety of lichen and moss species, be well-developed, and provide moderate to high cover.

Much of the area that originally supported this community has been converted for agricultural use or is now dominated by early seral plant communities. These early seral communities can be identified by the high cover of introduced species (e.g., *Bromus tectorum*), low cover (or absence) of needle-and-thread grass, sand dropseed, bluebunch wheatgrass, and junegrass, a reduction in forb diversity and lack of a cryptogam crust. See Lloyd et al. (1990) for more information.

This community occurs at lower elevations, on all aspects, from mid to lower slopes, mainly on gently sloping areas (occasionally steeper slopes). Soils consist of rapidly drained coarse-textured materials, derived from glacio-fluvial materials and often with a capping of eolian sands. In general, soils are classified as Brown Chernozems. Sites are dry to very dry (relative within subzone), often with drought conditions. Nutrient conditions, however, can range from poor to medium.

Distribution

Global

This plant community is described for the Columbia Basin and Owyhee Uplands of western Idaho, and eastern Washington and Oregon, and only occurs in the most southern portion of the Okanagan Valley in British Columbia.

British Columbia

This community occupies low elevations only at the southern end of the Okanagan Valley from Summerland to the U.S. border, with one small occurrence north of Kelowna.

Forest regions and district

Southern Interior: Okanagan Shuswap

Ecoprovince and ecosections

SOI: NOB, SOB

Biogeoclimatic unit

BG: xh1/02

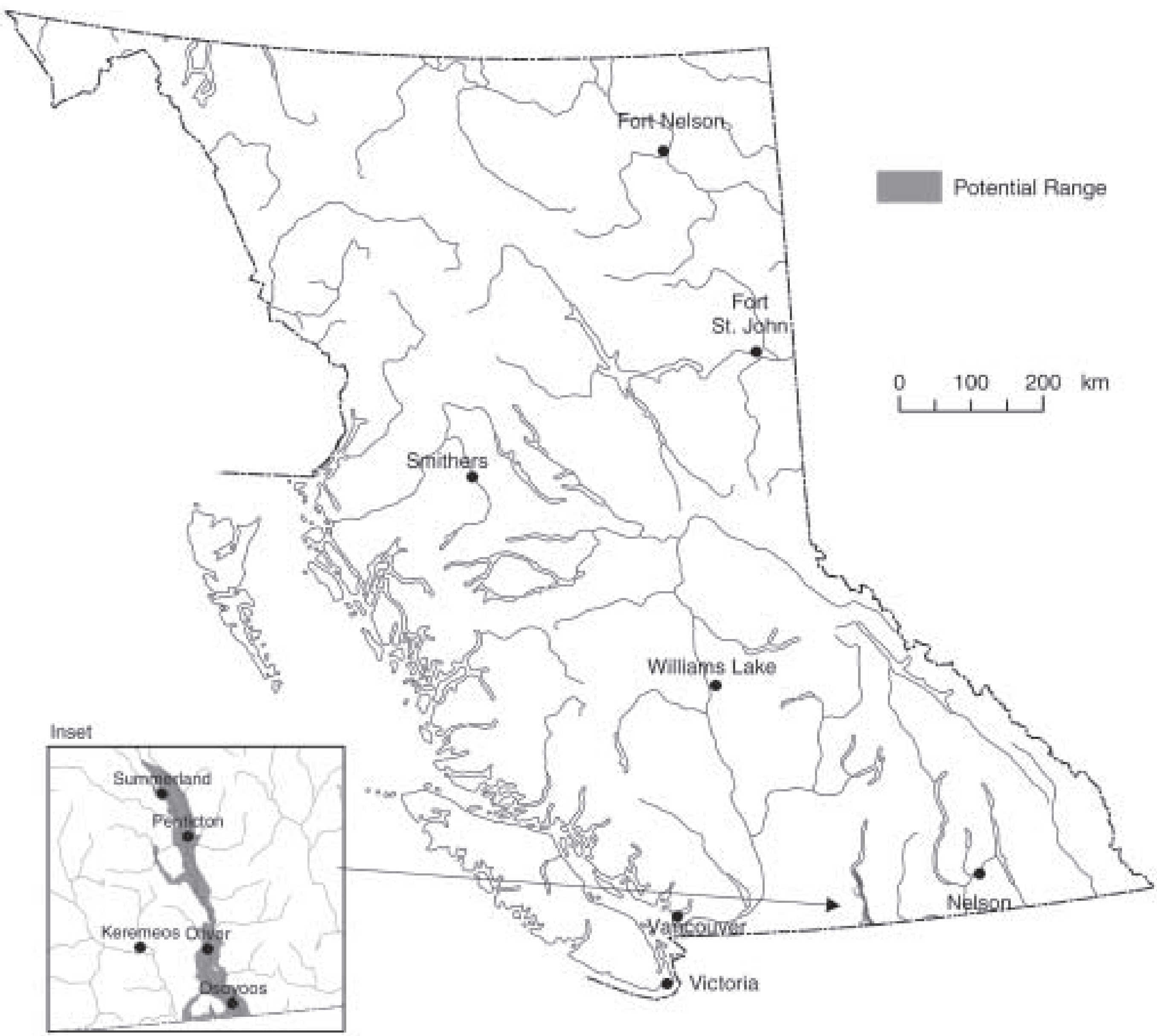
Broad ecosystem unit

AB

Elevation

280–760 m

Antelope-brush / Needle-and-thread Grass
(Purshia tridentata / Hesperostipa comata)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

Plant Community Characteristics

Structural stage

2: herb
3b: shrub/herb

Natural disturbance regime

Frequent stand-maintaining fires (NDT4) (MOF and MELP 1995). These areas would originally have experienced frequent low-intensity fires, and low intensity grazing by native ungulates as well as dry summers.

Fragility

High to very high. Droughty sites, very slow to recover from disturbance. Very susceptible to livestock grazing and very slow to recover to a late seral stage after intensive grazing. Exposure of the wind-blown soils frequently associated with this community means that these sites are highly susceptible to soil erosion.

Conservation and Management

Status

The antelope brush/needle-and-thread grass plant community is on the provincial *Red List* in British Columbia. It is ranked S1 in British Columbia and is globally ranked G2.

Trends

The areal extent of this plant community has been reduced from ~10 050 ha in 1860 to ~3900 ha in 2001. Only about 39% of the original land area of this community has not been converted to agricultural or urban developments (Lea 2001; Dyer and Lea 2002). The average rate of loss of this community has increased from 34 ha/yr between 1860 and 1938 to 52 ha/yr between 1938 and 1995, and to 90 ha/yr between 1995 and 2001 (Dyer and Lea 2002).

This community has a restricted range and where it occurs, it is generally in early to mid-seral stages (Lea and Maxwell 1995). There are few remaining late seral sites. Only two occurrences in climax condition have been located. Presently, only about 20 small areas (all <100 ha) occur on Crown land and these are in an earlier seral stages.

Similarly, within the United States, the number, condition, and size of stands has declined significantly due to land conversion to cultivation, intensive range management, introduction of invasive species, and alteration of fire disturbance regimes (NatureServe 2001). Few high-quality occurrences are known. Protected occurrences are typically not of high-quality condition and/or are small in size (NatureServe 2001).

Threats

The major threats to this plant community are the loss of area supporting this community to agricultural (orchards and vineyards) and urban development. Livestock grazing, which has occurred for over 100 years, has resulted in areas supporting this community to be dominated by early seral stages and has made them susceptible to establishment of invasive species. Other significant threats include all-terrain vehicles, transportation routes, sand and gravel extraction, resort development and sale of Crown land and probably climate change.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those within protected areas and parks.

Approximately 235 ha of this community occur within provincial protected areas and ~125 ha occur within a federal protected area.

The biodiversity and the range management guidelines of the *Forest and Range Practices Act* provide some protection for these communities. Range use planning may address this community through implementation of similar recommendations as outlined below in "General wildlife measures" below.

Identified Wildlife Recommendations

Sustainable resource management recommendations

At present most of the known occurrences of this plant community are in an early to mid seral stages and few if any are in a natural condition. It is recommended to:

- ❖ maintain or recover at least 20 occurrences in good condition across the range of the plant community;
- ❖ maintain or restore occurrences to as close to natural condition as possible and practical; and
- ❖ maximize north–south and low–high elevation connectivity between remaining fragmented occurrences.

Wildlife habitat area

Goals

Maintain and recover known occurrences.

Feature

Establish WHAs at occurrences that have been confirmed by a registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologist.

Size

The size of the WHA should be based on the extent of the community occurrence. At present, occurrences of this community are generally <100 ha.

Design

The WHA should include the entire community occurrence plus a 100 m, depending on the plant community type surrounding this community, to protect the community from edge effects (especially with respect to invasive species).

General wildlife measures

Goals

1. For most sites, maintain or restore to a late seral stage. For larger WHAs, maintain a mosaic of various seral stages and structure expected in natural conditions of this community.
2. Maintain or restore plant community to a natural state (i.e., same physical structure, and ecological processes as natural examples of the plant community) and natural plant composition of this plant community (see "Description").
3. Minimize or avoid access.
4. Minimize soil disturbance. Maintain or re-establish cryptogamic soil crust.
5. Minimize the introduction and spread of invasive species.

Measures

Access

- Do not develop roads or trails.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing (timing, distribution, and level of use) to meet general wildlife measure goals described above. Fencing could be required by the statutory decision maker to meet goals, to recover community, or for restoration treatments.
- Do not place livestock attractants within WHA.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation, soils and hydrology when operating adjacent to a WHA, particularly during road development and maintenance.

Restrict recreational use (i.e., dirt bikes, mountain bikes, and other off-road vehicles).

A prescribed fire program that approximates the natural fire regime could assist in the recovery of this plant community provided it is planned and implemented carefully. However, it may be difficult to duplicate historical fire patterns with only small fragments of the community remaining.

Cross References

Badger, Burrowing Owl, "Great Basin" Gopher Snake, Grasshopper Sparrow, Racer, Western Rattlesnake

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Vasey's Big Sagebrush/Pinegrass

Artemisia tridentata var. *vaseyana/Calamagrostis rubescens*

Original prepared by J. Pojar, S. Flynn, and C. Cadrin

Plant Community Information

Description

This shrub-steppe community has a shrub cover of Vasey's big sagebrush (*Artemisia tridentata* var. *vaseyana*) over a herb layer often dominated by Idaho fescue (*Festuca idahoensis*), and/or pinegrass *Calamagrostis rubescens*) depending on the location. Western meadowrue (*Thalictrum occidentale*), and wild strawberry (*Fragaria virginiana*) commonly occur in this community. Arctic lupine (*Lupinus arcticus* ssp. *subalpinus*), silky lupine (*Lupinus arcticus* ssp. *subalpinus*), sandworts (*Arenaria* and *Minuartia* spp.), old man's whiskers (*Geum triflorum*), junegrass (*Koeleria macrantha*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and fescue grasses (*Festuca* spp.) can also be found in this community, but with low cover (Lloyd et al. 1990).

This community occurs over morainal and colluvial blankets, on generally warm aspects, and on middle to upper slopes with steep to gentle gradients. Soils have fine to medium textures, are relatively dry (subxeric to submesic in this these subzones), and have medium to very rich nutrient regimes. Soils are occasionally shallow and rocky in the ESSFxc. Vasey's big sagebrush typically occurs on well-drained, moderately deep soils, but in contrast is restricted to cooler, moister mountain climates.

Distribution

Global

Unknown.

British Columbia

In British Columbia, this plant community is known from higher elevations in the southern and central interior, specifically at Mount Kobau, Greenstone Mountain, Tenas Mountain, the Ashnola Valley, and possibly Enderby Cliffs. It occurs as small patches sparsely distributed within a very limited range.

Forest region and districts

Southern Interior: Cascades, Kamloops, Okanagan Shuswap

Ecoprovince and ecosection

SOI: OKR, STU

Biogeoclimatic units

ESSF: xc/04
MS: xk/04

Broad ecosystem unit

SS

Elevation

1450–2060 m

Plant Community Characteristics

Structural stage

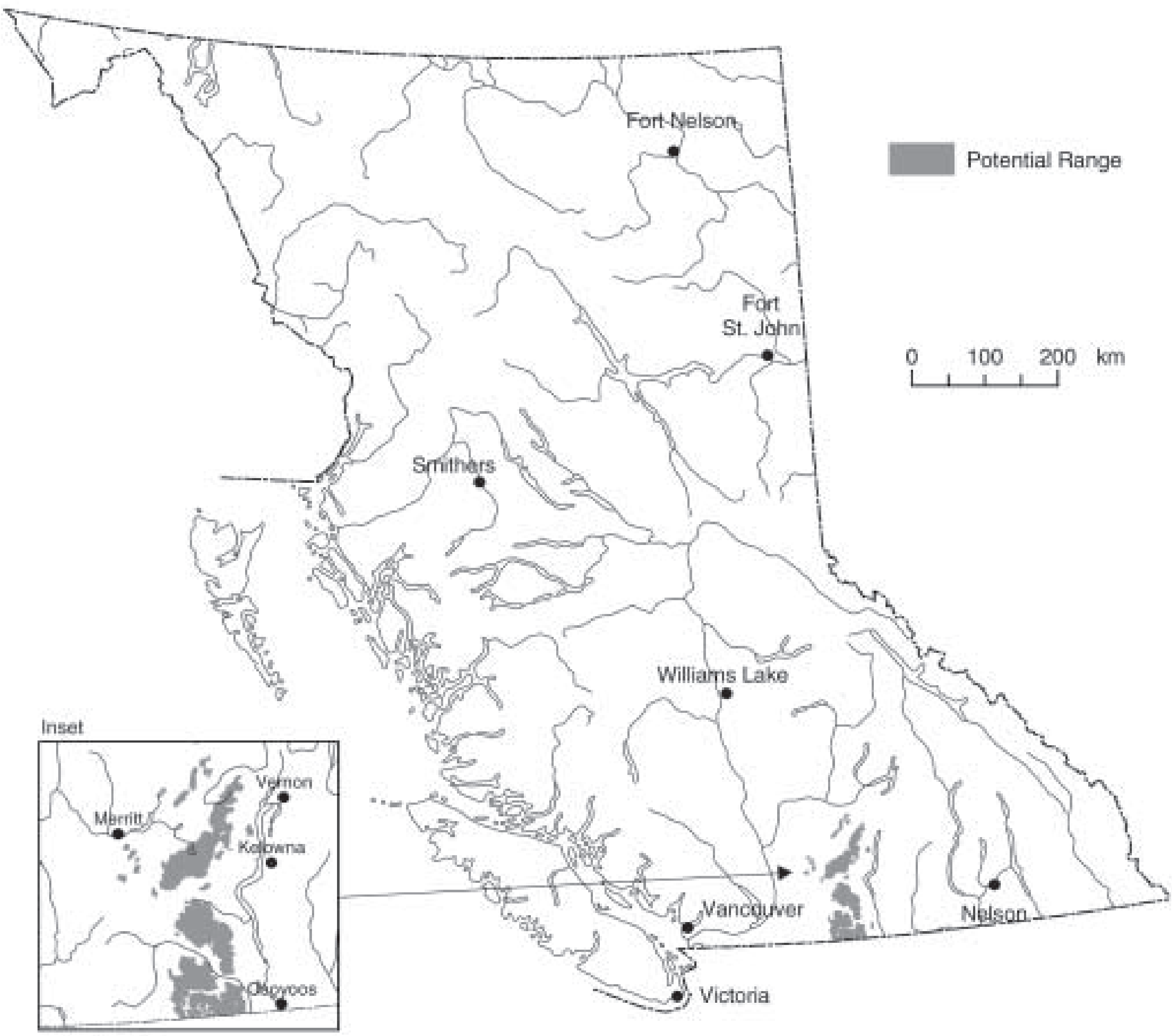
3: shrub/herb

Natural disturbance regime

Frequent stand-initiating events (NDT3) (MOF and MELP 1995) in particular light ground fires but also including periodic drought; grazing/browsing by native ungulates (mountain sheep, deer) and hare; and bark-eating voles, defoliating insects, and snowmold on Vasey's big sagebrush (Sturges and Nelson 1986). Grazing and browsing by native

Vasey's Big Sagebrush / Pinegrass

(Artemisia tridentata var. vaseyana / Calamagrostis rubescens)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

ungulates is an important modifying factor, as is grazing by domestic livestock. However, overgrazing may have resulted in major long-term shifts in vegetation composition and structure, serious disturbance to the soil surface, and spread of invasive plants.

Fragility

Moderate to high. Generally these communities should be less fragile than other shrub-steppe of warmer drier climates, especially if on deep soils, and may also be more resistant to invasion by introduced species and more resilient under moderate grazing pressure. However, they may be subject to intense grazing because of their higher productivity and their finer-textured soils make them more susceptible to compaction. Most occurrences have experienced some level of disturbance by livestock grazing (D. Lloyd, pers. comm.) and may have been invaded by weedy species.

Conservation and Management

Status

The Vasey's big sagebrush/pinegrass plant community is on the provincial *Red List* in British Columbia. It is ranked S1 in British Columbia. Its global status is unknown.

Trends

Currently known from <5 occurrences in British Columbia. Historically, the range of this plant community in British Columbia was very limited, and its distribution was sparse over this range. Most occurrences have experienced some level of disturbance by livestock grazing. It is doubtful if any occurrences of the community remain in a relatively undisturbed "climax" state. Their disturbed or degraded state will persist as long as the grazing pressure continues. Invasive species will probably increase. Ecosystem recovery will be slow, even if actively managed.

Threats

This plant community is threatened by invasive species, fire suppression, livestock grazing, and off-road vehicles and probably climate change. Heavy livestock grazing maintains this community in an early or mid-seral stage and may prevent it from reaching climax condition. Fire prevention and suppression result in ingress of young conifers.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those within protected areas and parks.

This community occurs in Mount Kobau Provincial Park and likely occurs in Cathedral and Apex Mountain provincial parks. The Greenstone Mountain occurrence is within an exclosure (R. Tucker, pers. comm.).

Range use plans under the *Forest and Range Practices Act* may address this community through implementation of similar recommendations as outlined below in "General wildlife measures" below.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- ❖ Control forest encroachment. A prescribed fire program that approximates the natural fire regime could assist in the recovery of this plant community.
- ❖ Maintain or recover at least 20 occurrences in good condition across the range of the plant community.
- ❖ Maintain or restore occurrences to as close to natural condition as possible and practical.

Wildlife habitat area

Goal

Maintain or recover known occurrences.

Feature

Establish WHAs at occurrences that have been confirmed by a registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologists. Priority for WHAs should be any climax occurrences of this community. As a lower priority, WHAs may be established within earlier seral stages where the key species of the community are present in small patches, to recover community to climax condition. When selecting candidate areas for recovery, select areas that are (in order of priority):

- closest to climax condition;
- can be expected to recover to a more natural state;
- near or adjacent to reserve areas; and
- adjacent to natural occurrences of other plant communities.

Size

The size of the WHA should be based on the extent of the plant community occurrence. Typically occurrences of this plant community are between 10 and 100 ha.

Design

The WHA should include the entire occurrence of the community plus 50 m surrounding the perimeter of the occurrence. Boundaries should be designed to minimize edge effects (especially of invasive species), and to allow the plant community to expand.

General wildlife measures

Goals

1. Maintain or restore plant community to a natural state (i.e., same species composition, physical structure, and ecological processes as natural examples of the plant community; see Lloyd et al. 1990).
2. Prevent physical disturbance, especially of the soil.
3. Minimize introduction and spread of invasive species.

Measures

Access

- Do not develop roads or trails.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to meet the general wildlife measure goals described above. Fencing could be required by the statutory decision maker to meet goals, to recover community, or for restoration treatments.
- Do not place livestock attractants within WHA.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation, soils, and hydrology when operating adjacent to a WHA, particularly during road development and maintenance.

Prescribed fire should be part of the management regime for this community, but it must be planned and implemented carefully, as part of an overall program of restoration, otherwise it may increase invasive species.

Restrict recreational use (i.e., dirt bikes, mountain bikes, and other off-road vehicles).

Protect from forest encroachment.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Determine historical distribution of community and reference conditions (i.e., pre-1850).
3. Map remaining known occurrences.

Cross References

Badger

References Cited

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Tucker, R. 2002. Min. Forests, Kamloops, B.C.

Douglas-fir/Common Juniper/Cladonia

Pseudotsuga menziesii/Juniperus communis/Cladonia

Original prepared by J. Pojar, S. Flynn, and C. Cadrin

Plant Community Information

Description

This dry forest community has an open canopy dominated by lodgepole pine (*Pinus contorta*) and Douglas-fir (*Pseudotsuga menziesii*). Douglas-fir is the most common regenerating tree species, but lodgepole pine usually persists through regeneration in the frequent canopy gaps. Common juniper (*Juniperus communis*) and tree regeneration dominate the sparse shrub layer, and are often accompanied by small amounts of soopolallie (*Shepherdia canadensis*), and prickly rose (*Rosa acicularis*). Kinnikinnick (*Arctostaphylos uva-ursi*) dominates the poorly developed herb layer, which typically includes bluebunch wheatgrass (*Pseudoroegneria spicata*), spreading needlegrass (*Achnatherum richardsonii*), spikelike goldenrod (*Solidago spathulata*), yarrow (*Achillea millefolium*), wild strawberry (*Fragaria virginiana*), Rocky Mountain fescue (*Festuca saximontana*), and Rocky Mountain butterweed (*Senecio streptanthifolius*). The lichen layer is dominated by cladonia lichens (*Cladonia* spp.), pelt lichens (*Peltigera* spp.), and lesser green reindeer lichen (*Cladina mitis*) (Steen and Coupé 1997).

This community occupies level to gently sloping positions including terraces and elevated inactive floodplains, with sandy or gravelly soils developed in glacio-fluvial and fluvial materials. Soils are subxeric to submesic (relative within subzone) and soil nutrient regime is very poor to poor.

Distribution

Global

Douglas-fir/common juniper/cladonia plant community occurs only in British Columbia in the IDFxm, a moderately sized (ca. 238 000 ha) subzone in south-central British Columbia.

British Columbia

This community is geographically very restricted. It occurs at lower elevations of the Chilcotin and Fraser river valleys from south of Alexandria west of Alexis Creek, in the valley bottoms of the Chilcotin and Chilanko rivers.

Forest region and districts

Southern Interior: 100 Mile House, Cascades, Central Cariboo, Chilcotin, Quesnel

Ecoprovinces and ecosections

CEI: CAP, CHP, FRB, QUL

SOI: PAR

Biogeoclimatic unit

IDF: xm/03

Broad ecosystem unit

DF

Elevation

650–950 m (up to 1200 m on warm aspects)

Plant Community Characteristics

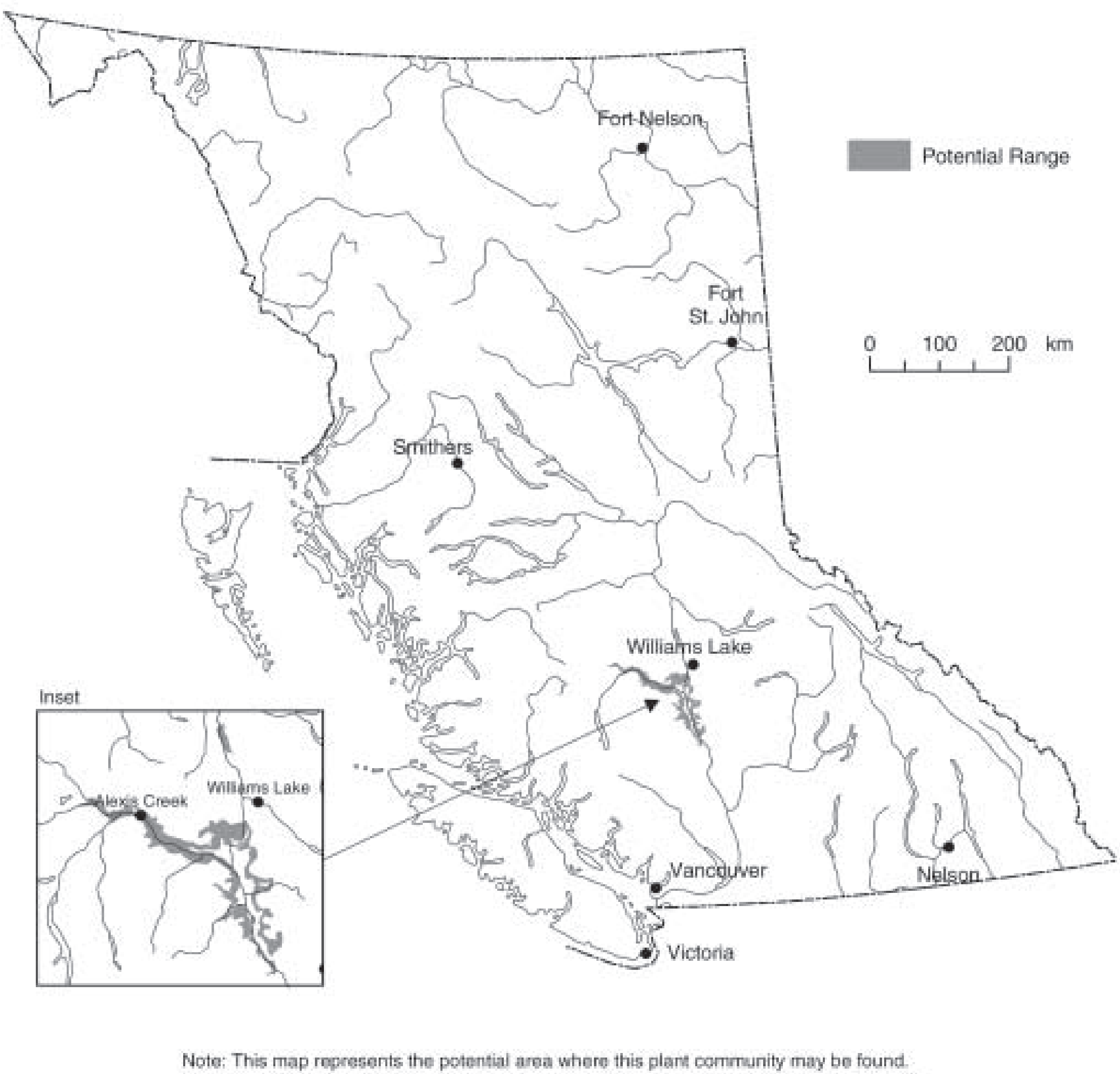
Structural stage

6: mature forest (100–200 years)

7: old forest (>200 years)

Douglas-fir / Common Juniper / Cladonia

(Pseudotsuga menziesii / Juniperus communis / Cladonia)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

Natural disturbance regime

Frequent stand-maintaining fires (NDT4) (MOF and MELP 1995). Fire is the main natural disturbance along with insect outbreaks, such as bark beetles and defoliators. Pine needle cast (*Lophodermella concolor*) has also been active over the last decade on some of these sites resulting in more open canopies.

Fragility

High. Generally these ecosystems recover slowly after stand-destroying or ground disturbances. Lichen cover is easily damaged by trampling and other traffic, and takes a long time to grow back. Soils are dry and low in nutrients, easy to degrade and slow to rebuild their capital of organic matter and nutrients; poor droughty soils can result in delayed and patchy forest regeneration and reduced plant growth. This community is very susceptible to invasive species after disturbance of the soil surface.

Conservation and Management

Status

The Douglas-fir/common juniper/cladonia plant community is on the provincial *Red List* in British Columbia. It is ranked S2 in British Columbia and G2 because it occurs nowhere else.

Trends

Declining. This community is restricted to a very small range and one biogeoclimatic subzone (IDFxm). There are probably <50 occurrences and older high-quality occurrences are very small and rare. Much of the range of this plant community has been subject to long history of disturbance by humans, including cattle ranching, clearing and settlement. This community is naturally small and localized, but the localities are favoured for transportation corridors and opportunistic, small-scale logging. The community has been depleted to near-extirpation, at least in the IDFxm in British Columbia. Originally fragmentary and insular, it is even more so now. A few high quality occurrences remain, as small patches in a matrix of degraded habitats.

Threats

Threatened by forest harvesting, road construction, mining of granular materials for road construction, livestock grazing, and residential development, and probably climate change. This plant community is threatened by development of transportation corridors because of its valley bottom location and geomorphological characteristics. Although occurrences of this plant community are generally too small and produce insufficient forage to be a target for livestock grazing, impacts such as grazing, trampling, soil disturbance and possibly the introduction of invasive species may occur. In the long term, fire suppression will be a threat to this community as Douglas-fir could take over the old stands, excluding the lodgepole pine and changing the understorey, and recruitment of young stands would be curtailed without stand-replacing disturbances such as fire.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those within protected areas and parks. There are no known occurrences of this community in existing or proposed protected areas (R. Coupé, pers. comm.).

Under the *Forest and Range Practices Act*, old growth management areas could be placed to protect some occurrences.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

This small patch community is uncommon and sparsely distributed over a limited range of ~250 000 ha in central British Columbia. Because of their small size, it may be necessary to protect these communities within a larger matrix of other red- or blue-listed communities. It is recommended to:

- ❖ maintain or recover at least 20 occurrences in good condition across the range of the plant community;
- ❖ maintain or restore occurrences to as close to natural condition as possible and practical;
- ❖ maximize connectivity of old forest within the IDFxm; and
- ❖ wherever possible, protect remaining occurrences through the placement of old growth management areas.

Wildlife habitat area

Goal

Maintain or recover known occurrences that could not be addressed through landscape level planning and the designation of old growth management areas.

Feature

Establish WHAs at occurrences that have been confirmed by a registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologists. Priority for WHAs should be any old or mature (structural stage 6 and 7) occurrences of this community that are >5 ha and in a relatively natural state. Most high-quality occurrences are along the Chilcotin River west of Clinton. As a lower priority, establish WHAs within younger forests established after natural disturbance and allow recovery to climax condition. Select areas that are (in order of priority):

- the oldest, most structurally complex secondary forests available, ideally stands containing a component of veteran lodgepole pine and Douglas-fir;
- relatively lightly damaged and can be expected to recover to a more natural state;
- part of a network of reserve areas; and
- adjacent to natural occurrences of other plant communities.

Size

The size of the WHA should be based on the extent of the plant community occurrence. Typically occurrences of this plant community are between 10 and 50 ha.

Design

The WHA should include the entire occurrence of the community plus 150 m (approximately five tree heights) surrounding the occurrence. Wherever possible use geographic or topographic boundaries. If boundaries are limited due to some artificial barrier such as roads, rights of way, and developed areas, then increase size at other sections of the boundaries. Boundaries should be designed to minimize edge effects and to the extent possible, be delineated along windfirm boundaries.

General wildlife measures

Goals

1. Maintain or restore plant community to a natural state (i.e., same species composition, physical structure, and ecological processes as natural examples of the plant community; see Steen and Coupé 1997).
2. Maintain generally open forest canopies, or a range from very open to closed, but maintain a sparse shrub cover (including tree regeneration).
3. Maintain a diversity of natural disturbance regimes.
4. Allow for the processes of litter accumulation, renewal and microbiotic crust development.
5. Prevent physical disturbance, especially of the soil.
6. Maintain or enhance old forest structure (i.e., some large old trees, range of tree sizes, large snags, down logs, canopy depth and roughness, horizontal patchiness of understorey) (Spies 1998).
7. Maintain regeneration and recruitment of lodgepole pine.
8. Minimize introduction and spread of invasive species.

Measures

Access

- Do not develop roads or trails.

Harvesting and silviculture

- Do not harvest or salvage except when required to create a windfirm edge.
- Do not remove non-timber forest products.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing (i.e., timing, distribution and level of use) to meet general wildlife measure goals described above. Fencing could be required by the statutory decision maker to meet goals, to recover community, or for restoration treatments.
- Do not place livestock attractants within WHA.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation and soils when operating adjacent to a WHA, particularly during road development and maintenance.

A mix of well-considered silvicultural treatments (e.g., girdling, thinning, and fill-planting) and prescribed fire will be required to maintain desired stand conditions, lichen ground cover, and to control excessive Douglas-fir ingress and more shade-tolerant understorey vegetation.

Restrict recreational use (i.e., dirt bikes, mountain bikes, and other off-road vehicles).

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Mapping and assessment of the quality of remaining occurrences of this community.
3. Identification of candidate forests for recruitment.

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Steen, O. and R. Coupé. 1997. A field guide for the forest site identification and interpretation of ecosystems of the Cariboo Forest Region. B.C. Min. For., Williams Lake, B.C. Land Manage. Handb. No. 39.

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DOUGLAS-FIR/SNOWBERRY/BALSAMROOT

Pseudotsuga menziesii/Symphoricarpos albus/Balsamorhiza sagittata

Original prepared by W.R. Erickson

Plant Community Information

Description

This plant community is characterized by open or savannah type stands of Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*), with a herb layer dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*), arrow-leaved balsamroot (*Balsamorhiza sagittata*), and Idaho fescue (*Festuca idahoensis*). Pinegrass (*Calamagrostis rubescens*) grows on some sites, usually where tree cover is denser or in more protected positions. The shrub layer is generally sparse and may include snowberry (*Symphoricarpos albus),* saskatoon (*Amelanchier alnifolia*), antelope-brush (*Purshia tridentata*), kinnickinnick (*Arctostaphylos uva-ursi*), common juniper (*Juniperus communis*), Rocky mountain juniper (*Juniperus scopulorum*), soopolallie (*Shepherdia canadensis*), or wood rose (*Rosa woodsii*).

The herb layer may include a low cover of slender hawksbeard (*Crepis atribarba*), dogbane (*Apocynum androsaemifolium*), needlegrasses (*Achnatherum* spp.), fescues (*Festuca* spp.), timber milkvetch (*Astragalus miser*), rosy pussytoes (*Antennaria microphylla*), junegrass (*Koeleria macrantha*), yarrow (*Achillea millefolium*), strawberry (*Fragaria virginiana*), fern-leaved desert parsley (*Lomatium triternatum*), and nodding onion (*Allium cernuum*). Occasionally, moss cover (*Tortula ruralis*, and *Peltigera rufescens)* and lichen cover (*Cladonia* spp.) is relatively well developed (Braumandl and Curran [compilers and editors] 1992).

Distribution is restricted to ridges and upper to mid-slopes on warm aspects. It occurs on a variety of parent materials. Soils can vary, but are often loamy and classified into Chernozemic, Brunisolic, or Luvisolic soil orders. Soil moisture classes have been assigned as subxeric to submesic (Braumandl and Curran [compilers and editors] 1992). These soils tend to be rich, as melanization by root decomposition is important, along with periodic reductions in surface litter from repeated fire.

Distribution

Global

Unknown.

British Columbia

The range of this plant community in British Columbia is very limited. It is restricted to valley bottoms and adjacent slopes in the lower Rocky Mountain Trench, occurring south of the Blaeberry River to the international border.

Forest region and district

Southern Interior: Rocky Mountain

Ecoprovince and ecosection

SIM: EKT

Biogeoclimatic units

IDF: dm2/03
MS: dk
PP: dh2/00

Broad ecosystem units

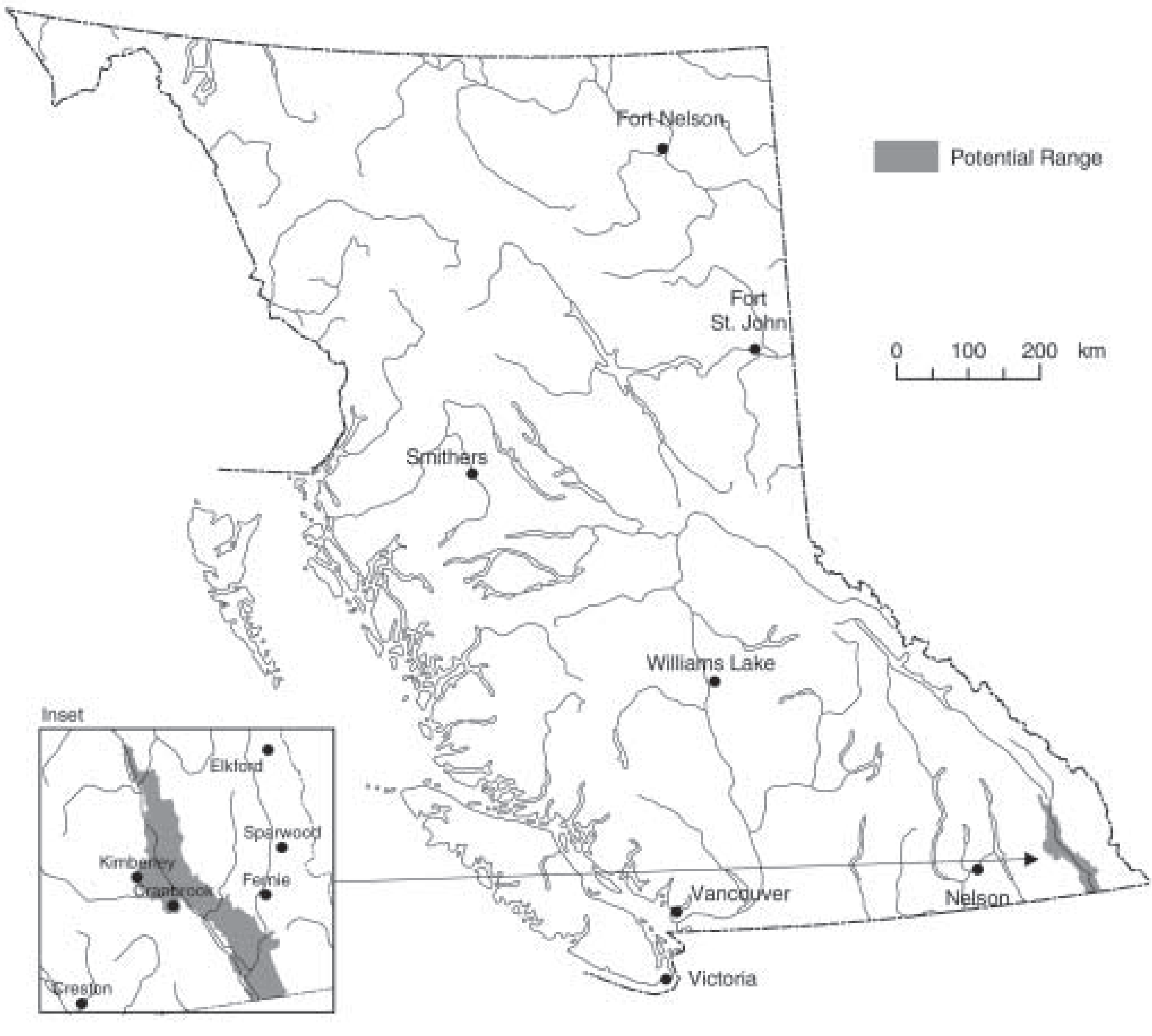
DP, PP

Elevation

~700–1500 m

Douglas-fir / Snowberry / Balsamroot

(Pseudotsuga menziesii / Symphoricarpos albus / Balsamorhiza sagittata)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

Plant Community Characteristics

Structural stage

6 and 7 with open savannah characteristics

Natural disturbance regime

Frequent stand-maintaining fires (NDT4) (MOF and MELP 1995b). Periodic fire, grazing and browsing, and insect outbreaks are among the historic natural disturbances for this community (Youtie et al. 1988; MOF and MELP 1995a; Rondeau 2001; Univ. Wyoming, n.d.; D. Johnson, pers. comm.). Collectively these disturbances would maintain more open forest and understorey stands, but provide renewal or replacement opportunities where plant growth or vigour was stagnated due to density, low light conditions, and competition.

Conditioning of the vegetation by native ungulates is part of the natural ecosystem processes of this community. The subzone variant area supports large populations of mule deer, white-tailed deer, elk, and bighorn sheep, especially as winter range. The understorey species of this community are generally adapted to and resilient to disturbance. An exception is the susceptibility of bluebunch wheatgrass and Idaho fescue to spring defoliation by herbivores (McLean and Marchand 1968). Evidence suggests that the current composition may represent the impacts of grazing pressure with more dominance by snowberry and balsamroot, and less by Idaho fescue and bluebunch wheatgrass (McLean and Marchand 1968; Youtie et al. 1988; Williams et al. 1995; Thompson et al. 1998; Harrison 2000; Thompson, n.d.). There most likely have been exchanges in dominance for these last two species on late seral sites. Increased grazing pressure has resulted in conversion of this plant community to pussytoes species, needlegrasses, weedy forbs, and invaders such as cheatgrass (McLean and Marchand 1968).

On many sites, considerable changes have resulted from the lack of natural disturbance regimes over the last 150 years (Gayton 1996). These include increasing tree densities, invasion of pinegrass and moss, deep accumulations of litter and woody debris, elimination of understorey, and changes in soil forming processes.

Fragility

Moderately fragile on coarse soils and steeper slopes. Vegetation can recover after forest harvesting, but could take a long time to return to old-growth condition in the dry hot climate with occasional periods of drought. Once vegetation is removed and soils exposed, early succession will probably be dominated by invasive species that will persist. These ecosystems are very susceptible to the introduction and spread of invasive species.

Conservation and Management

Status

The Douglas-fir/snowberry/balsamroot plant community is on the provincial *Red List* in British Columbia. It is ranked S2 in British Columbia. Its global status is unknown. No comparable community has yet been identified in adjacent jurisdictions.

Trends

Assessed as declining in British Columbia, and there are estimated to be <20 remaining viable occurrences in good condition (i.e., large stands of old open forest, relatively undisturbed—not logged, not or lightly grazed by domestic livestock, without invasive species, and free of the dense coniferous ingrowth that results from fire exclusion). It is expected to continue to decline due to fire prevention and suppression, forest harvesting, rural development, poor range practices, and the spread of invasive species. There have probably been gains with changing range practices, but the overall decline is not likely to reverse without control of invasive species, forest encroachment and ingrowth.

Threats

Forest encroachment and ingrowth due to fire suppression, livestock and wildlife grazing/browsing impacts, spread of invasive species, harvesting of older stands and probably climate change threaten the long-term viability of this plant community.

Habitat has been and continues to be lost to urbanization, impoundments, golf course development, and intensive agriculture. Outdoor recreation (e.g., trail bikes), extensive livestock grazing and wildlife grazing/browsing can increase soil exposure, increasing the spread of invasive species. Overuse also impacts native plant vigour and composition and ecosystem stability.

Classic studies by McLean and Marchand (1968) in related habitats indicate the long period of recovery required from an early seral state. Many of these sites may be stalled in a state with Kentucky bluegrass (*Poa pratensis*), cheatgrass (*Bromus tectorum*), or needlegrass dominance and may require management treatments for recovery (Westoby et al. 1989).

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those occurring within protected areas and parks.

There are several small protected areas or managed areas within the biogeoclimatic subzone variants in which this community occurs but it is not known if these areas include this community. Roughly 2500 ha is in 15 small protected areas. This community does occur in Kikomun Park as well as Sheep Mountain and Premier Ridge wildlife management areas. It may also occur in other wildlife management areas and in other provincial parks, particularly Premier Lake and Norbury Lake.

Occurrences of this community could be protected through the establishment of old growth management areas (OGMAs) under the *Forest and Range Practices Act*. No areas have been designated to date.

Old growth guidelines have not been applied to open savannah stands, but should be relevant to this community. This is an upland community to which riparian management guidelines do not apply. Range use planning may address this community through implementation of similar recommendations as outlined below in “General wildlife measures.”

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

This small to large patch community once occurred more commonly over the landscape. It is recommended to:

- ❖ re-establish periodic understorey fire as an ecological factor conditioning stands;
- ❖ control forest ingrowth and encroachment;
- ❖ maintain or recover at least 20 occurrences in good condition across the range of the plant community;
- ❖ maintain or restore occurrences to as close to natural condition as possible and practical; and
- ❖ wherever possible, protect remaining occurrences through placement of old growth management areas.

Wildlife habitat area

Goal

Maintain or recover known occurrences.

Feature

Establish WHAs at occurrences that have been confirmed by a registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologists. Priority for WHAs should be any old or mature (structural stage 6 and 7) occurrences of this community that are >10 ha and in a relatively natural state. As a lower priority, establish WHAs within younger forests (stage 5) originating from natural disturbance events) where the key species of the community (balsamroot, bunchgrasses, snowberry) are present in small patches, to recover community to climax condition.

Select areas that are (in order of priority):

- the oldest, most structurally complex secondary forests available, ideally stands containing a component of veteran ponderosa pine and Douglas-fir;
- relatively lightly damaged and can be expected to recover to a more natural state;
- part of a network of reserve areas; and
- adjacent to natural occurrences of other plant communities.

Size

The size of the WHA should be based on the extent of the community occurrence. This plant community tends to occur as small to medium patches. WHAs will be ~50 ha when in relatively pure composition, or where recovery is the main objective. However, WHAs may be larger (~200 ha) when the understorey community or tree layer has a patchy distribution or when the community occurs in complexes with other at-risk plant communities.

Design

The WHA should include the entire occurrence of the plant community plus ~100 m around the perimeter of the occurrence. Wherever possible use geographic or topographic boundaries. If boundaries are limited due to some artificial barrier such as roads, rights of way, developed areas, then increase the size at other sections of the boundaries. Minimize edge, unless occurrences are narrow, such as along ridge tops. In these cases, include occurrence plus 200 m around the perimeter of the plant community occurrence.

General wildlife measures

Goal

1. Maintain or restore plant community to a natural state (i.e., same species composition, physical structure, and ecological processes as natural examples of the plant community) (see Brayshaw 1970; McLean 1970; Braumandl and Curran [compilers and editors] 1992).
2. Maintain or enhance open old forest structure (i.e., some large old trees, range of tree sizes, large snags, down logs) (Spies 1998).
3. The recommended Desired Plant Community is as follows: open savannah canopy cover 2–35%, widely, spaced large Douglas-fir and ponderosa pine, herb layer dominated by >5%, preferably >15% cover of at least two of bluebunch wheatgrass, arrow-leaved balsamroot, or Idaho fescue.
4. Manage to maintain and increase the species named above as the Desired Plant Community.
5. Maintain a diversity of natural disturbance regimes.
6. Allow for the processes of litter accumulation, renewal, and microbiotic crust development.
7. Maintain a diversity of understorey species composition (e.g., *Festuca* spp.). Maintain or restore native grass-dominated ground cover.
8. Prevent physical disturbance, especially of the soil.
9. Avoid or minimize access.
10. Minimize introduction and spread of invasive species.

Measures

Access

- Do not build roads or trails.

Harvesting and silviculture

- Do not harvest or salvage except to support restoration measures with silvicultural treatments. Retain widely spaced, large, older trees and snags.
- Do not remove non-timber forest products.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing (i.e., timing, distribution, and level of use) to meet goals described above. Fencing could be required by the statutory decision maker to meet goals, to recover community, or for restoration treatments.
- Do not place livestock attractants within WHA.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation, soils, and hydrology when operating adjacent to a WHA, particularly during road development and maintenance.

This community is part of broader fire-maintained ecosystems, which have been subject to fire suppression and consequent forest encroachment and ingrowth (Arno et al. 1995; Gayton 1996; Hardy and Arno [editors] 1996; RMTER 2000). Key to restoring this community is to emulate the effects of this former natural fire regime by establishing restoration silvicultural treatments (such as limbing to prevent surface fires from crowning) and light intensity, prescribed burns in fall (Thomson 1988; Arno et al. 1995; Zlatnik 1999a, 1999b). Maintain and restore saskatoon, bluebunch wheatgrass, Idaho fescue, and balsamroot cover; cycles of litter and biotic crust accumulation and light intensity natural fire renewal. Increase cover and diversity of other native species (e.g., forbs, rough fescue) and maintain open savannah to open forest structure (e.g., 15–30% cover) of older (e.g., >150 year old) ponderosa pine and Douglas-fir trees.

Light to moderate grazing/browsing and periodic renewal are necessary as part of the disturbance regime for this community, but higher levels can cause the loss of the community through shifts in competition-mediated shifts in composition and species invasions (McLean and Marchand 1968; Ross 1997). In addition, the key species of the community still have susceptibilities to higher burn intensities in different seasons (Thomson 1988; Zlatnik 1999a, 1999b). Using light intensity prescribed burns in fall 'is a compromise between these susceptibilities and the difficulties of a spring burn window before the onset of bunchgrass growth. Burns should be able to be carried out under a regular burn plan, plus species-level monitoring, without the need for a specific site management plan. Silvicultural treatments should leave older trees and snags, which have an important role for wildlife of open savannah and open forests.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Review guidelines for old growth and open savannah stands, and apply them in the management of a pilot project area.
3. Monitor for recovery trends in relation to site factors and restorations treatments, and for the relationship between specific community types currently encompassed within this community.

Cross References

Lewis's Woodpecker

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Hybrid White Spruce/Ostrich Fern

Picea engelmannii × glauca/Matteuccia struthiopteris

Original prepared by J. Pojar, S. Flynn, and C. Cadrin

Plant Community Information

Description

This forested community has a fairly open canopy dominated by large hybrid white spruce (*Picea engelmannii* x *glauca*), but also including subalpine fir (*Abies lasiocarpa*), black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), and paper birch (*Betula papyrifera*). Mountain alder (*Alnus incana* ssp. *tenuifolia*), red-osier dogwood (*Cornus stolonifera*), red elderberry (*Sambucus racemosa* ssp. *pubens*), and devil's-club (*Oplopanax horridus*) dominate the vigorous shrub layer. The well-developed herb layer includes an abundance of ostrich fern (*Matteuccia struthiopteris*), horsetails (*Equisetum* spp.), stinging nettle (*Urtica dioica*), enchanter's-nightshade (*Circaea alpina*), northern golden-saxifrage (*Chrysosplenium tetrandrum*), one-leaved foamflower (*Tiarella trifoliata* var. *unifoliata*), and large-leaved avens (*Geum macrophyllum*). Moss cover is low, and consists primarily of leafy mosses (*Mnium* spp.) and *Brachythecium*. See DeLong (1996), and Steen and Coupé (1997) for more information.

This community occupies toe and level slope positions with medium-textured to somewhat fine-textured (sandy to loamy), fluvial deposits. Sites are usually on or near floodplains and subject to persistent seepage and periodic flooding. Soils are moist to very moist (relative within subzone), and have a rich to very rich nutrient regime.

Distribution

Global

Restricted to British Columbia, occurring only in the SBSmh, a rather small (ca. 108 000 ha) subzone in the central interior.

British Columbia

This community is restricted to floodplains and toe slopes of the Fraser River valley, from Alexandria and Hydraulic north to Prince George, and of the Quesnel River valley downstream of Quesnel Forks.

Forest regions and districts

Northern Interior: Prince George

Southern Interior: Central Cariboo, Quesnel

Ecoprovinces and ecosections

CEI: CAP, QUL

SBI: NEL

Biogeoclimatic unit

SBS: mh/08

Broad ecosystem unit

WR

Elevation

450–750 m

Plant Community Characteristics

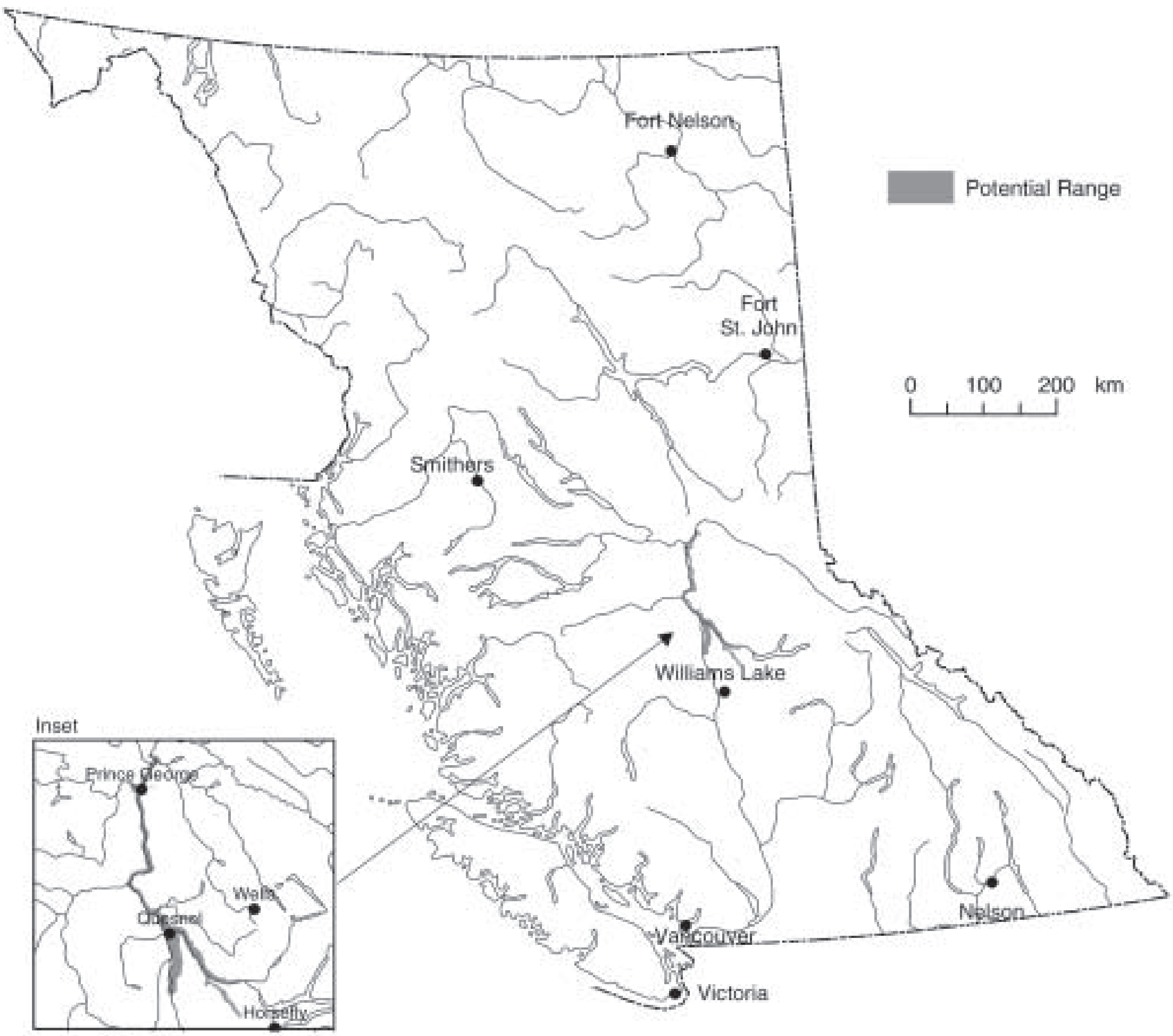
Structural stage

6: mature forest (some of the more structurally complex stands, usually >80 years)

7: old forest (>140 years)

Hybrid White Spruce / Ostrich Fern

(Picea engelmannii x glauca / Matteuccia struthiopteris)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

Natural disturbance regime

Frequent stand-initiating events (NDT3) (MOF and MELP 1995), wildfire (although these valley bottom forests are less likely to burn than those on adjacent uplands), major floods, windthrow, and erosion. Overbank floods occur occasionally, as part of the natural hydrological regime. Fairly frequent direct mortality of individual or small groups of trees due to bark beetles, root rots, and defoliating insects, or indirect mortality via predisposition of attacked trees to blowdown.

Fragility

Moderately fragile. Soils typically are deep, medium-textured, moist, and nutrient-rich. The soils are moist to wet, however, and sometimes occur on unstable landforms, and so are susceptible to mass movements and water table changes, especially those triggered by land clearing or forestry activity such as road building. Overbank floods occur occasionally, but are part of the natural hydrological regime. The ecosystems should recover relatively quickly after stand-destroying disturbances, provided biological legacies such as snags and large downed logs persist on site and there has been no damage or displacement of soil materials. These rich moist sites are prone to sudden growth of shrubs after major disturbances, which can result in deciduous "brush" competition with conifers, delays in forest regeneration and slower forest recovery after disturbance.

Conservation and Management

Status

The hybrid white spruce/ostrich fern plant community is on the provincial *Red List*. In British Columbia this community is ranked S2 and its global status is proposed as G2.

Trends

Although widespread, this small, linear ecosystem is uncommon within a localized range. It has been seriously depleted and old and mature stands continue to decline in distribution. Ecologists estimate that <20 high quality occurrences remain. This trend is likely to continue.

Threats

The SBSmh is a small subzone with a history of disturbance by humans and many productive forest sites have been logged. Its high value as timber has resulted in serious depletion. Significant areas of the subzone (including this community) have also been cleared for agriculture, ranching, and rural settlement. Climate change may also be a threat.

Connectivity of old forest habitat in the subzone is a serious conservation issue, especially along the major riparian corridors where the hybrid white spruce/ostrich fern community occurs, particularly on the extensive private timber lands.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those within protected areas and parks.

There may be some representation in Fraser River and Fort George Canyon parks, but occurrences need verification. The SBSmh as a whole has only 2% (~2200 ha) of its area protected.

The *Forest Practices Code* guidelines for riparian management areas would apply to many of the occurrences, but may be too narrow to provide adequate protection. Old growth management areas may protect some occurrences if old forest retention objectives cannot be met in the non-timber harvesting land base.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

The distribution of this community has always been patchy and dynamic, but few old patches now remain and few young patches are being recruited. It occurs as small patch forests and most typically as linear systems along creeks, streams, and floodplains of larger rivers. It is recommended to:

- ❖ maintain water flow and hydrological conditions supporting this plant community and, where possible, preserve or restore natural flood cycles that historically maintained this community;
- ❖ maximize connectivity of old forest within the SBSmh;
- ❖ maintain or recover at least 20 occurrences in good condition across the range of the plant community;
- ❖ maintain or restore occurrences to as close to natural condition as possible and practical; and
- ❖ wherever possible, protect remaining occurrences through the placement of old growth management areas.

Wildlife habitat area

Goal

Maintain or recover known occurrences that could not be addressed through landscape level planning and the designation of old growth management areas.

Feature

Establish WHAs at occurrences that have been confirmed by a registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologists. Priority for WHAs should be any old or mature (structural stage 6 and 7) within younger stands to attain a minimum 5 ha and in a relatively natural state. As a lower priority, establish WHAs within younger, relatively undisturbed forests and riparian systems that include this plant community to recover community to climax condition. Select areas that are or have (in order of priority):

- the oldest, most structurally complex secondary forests available;
- intact hydrological processes that are relatively lightly damaged and can be expected to recover to a more natural state;
- part of a network of reserve areas; and
- adjacent to natural occurrences of other plant communities.

Size

The size of the WHA should be based on the extent of the plant community occurrence. Typically occurrences of this plant community are linear and are between 5 and 80 ha along rivers and streams.

Design

The WHA should include the entire occurrence of the community plus ±80 m (approximately two tree heights) along the upland side of the linear occurrence or surrounding the small patch toe slope occurrences. Boundaries should be designed to minimize edge effects and to the extent possible, be delineated along windfirm boundaries.

General wildlife measures

Goals

1. Maintain or restore plant community to a natural state (i.e., same species composition, physical structure, including coniferous canopy and deciduous composition, and ecological processes as natural examples of the plant community; see Steen and Coupé 1997).
2. Maintain or restore the natural hydrological regime within WHA. Seepage, fluctuating and seasonally high water tables, and occasional major overbank floods are fundamental to the ecology of these riparian ecosystems.
3. Maintain or enhance old forest structure (i.e., large old trees, range of tree sizes, large snags, down logs, canopy depth and roughness, multiple vegetation strata, horizontal patchiness of understorey) (Spies 1998).
4. Maintain open forest-interior conditions.
5. Prevent physical disturbance, especially of the soil.
6. Minimize introduction and spread of invasive species.

Measures

Access

- Do not develop roads or trails.

Harvesting and silviculture

- Do not harvest or salvage except when required to create a windfirm edge.
- Do not remove non-timber forest products.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing (timing, level of use, distribution) to meet general wildlife measure goals. Fencing could be required by the statutory decision maker to meet goals, to recover community, or for restoration treatments.
- Do not place livestock attractants within WHA.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation, soils, and hydrology in areas immediately surrounding WHA. These considerations apply particularly to land clearing, and road location, construction, and maintenance.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Mapping and assessment of the structural stage, successional dynamics, quality, and integrity of the remnant occurrences.
3. Identification of candidate forests for recruitment.

Cross References

Bull Trout, Fisher

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Ponderosa Pine/Bluebunch Wheatgrass–Silky Lupine

Pinus ponderosa/Pseudoroegneria spicata–Lupinus sericeus

Original prepared by J. Pojar, S. Flynn, and C. Cadrin

Plant Community Information

Description

These open forests have a canopy of ponderosa pine (*Pinus ponderosa*) often mixed with Douglas-fir (*Pseudotsuga menziesii*). The shrub layer is sparse, with saskatoon (*Amelanchier alnifolia*), snowberry (*Symphoricarpos albus*) (PPdh1), and wood rose (*Rosa woodsii*) (PPdh2). The herb layer is dominated by grasses, in particular bluebunch wheatgrass (*Pseudoroegneria spicata*), with also junegrass (*Koeleria macrantha*), fescues (*Festuca* spp.), and needlegrasses (*Achnatherum* and *Hesperostipa* spp.). With increased disturbance to the community, grasses such as cheatgrass (*Bromus tectorum*) may become dominant. This plant community also has a variety of forbs, but with low cover. Forbs include silky lupine (*Lupinus sericeus*), yarrow (*Achillea millefolium*), rosy pussytoes (*Antennaria rosea*), arrow-leaved balsamroot (*Balsamorhiza sagittata*), nodding onion (*Allium cernuum*) (PPdh1), and prairie crocus (*Anemone patens*) (PPdh2) (Braumandl and Curran [compilers and editors] 1992).

These forests occupy a variety of slope positions and aspects, on gentle to steep slopes. Parent materials can be glacio-fluvial, colluvial, morainal, lacustrine, or aeolian (veneers) in origin. Soils have mostly loamy or silty textures and Moder or Mull humus forms. The soil moisture regime is mesic to submesic (relative within subzone), while the soil nutrient regime varies from poor to rich.

Distribution

Global

Relatively widespread in southeastern British Columbia and possibly into northeastern Washington, Idaho, western Montana) of the Western montane conifer forest formation of North America (Daubenmire and Daubenmire 1968; Franklin and Dyrness 1973; Barbour and Christensen 1993).

British Columbia

This plant community occupies the southern extremities of the Kettle River Valley between Johnstone Creek and Boundary Falls, and between July Creek and Christina Lake. It also occurs in the Rocky Mountain Trench between Skookumchuck Creek and the St Mary River, and between Baynes Lake and Tobacco Plains.

Forest region and districts

Southern Interior: Arrow Boundary, Rocky Mountain

Ecoprovinces and ecosections

SIM: EKT

SOI: SOH

Biogeoclimatic units

PP: dh1 (Kettle)/01, dh2 (Kootenay)/01

Broad ecosystem unit

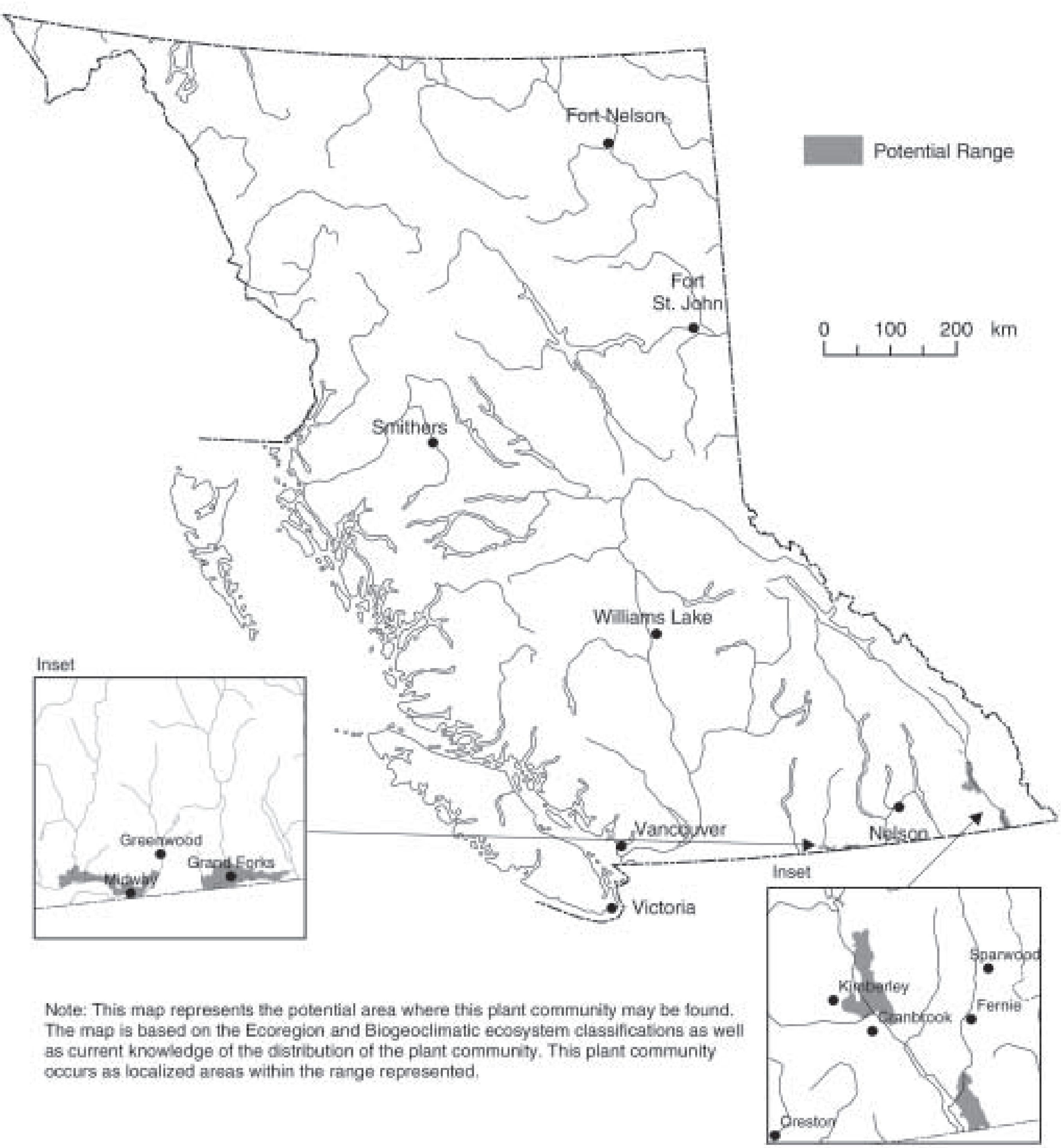
PP

Elevation

500–950 m

Ponderosa Pine / Bluebunch Wheatgrass - Silky Lupine

(Pinus ponderosa / Pseudoroegneria spicata - Lupinus sericeus)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

Plant Community Characteristics

Structural stage

6: mature forest (some of the more structurally complex stands, usually >140 years)
7: old forest (>200 years)

Natural disturbance regime

Frequent stand-maintaining fires (NDT4) (MOF and MELP 1995), primarily low intensity ground fires, previously characterized the natural disturbance regime of these open grassy forests (Arno et al. 1995). Other important agents of disturbance and tree mortality include bark beetles, defoliating insects, root diseases, and occasional drought and wind (Johnson 1994; Campbell and Liegel [technical coordinators] 1996; Parminter 1998). Grazing and browsing by native ungulates is an important modifying factor; conditioning of the vegetation by native ungulates is part of the natural ecosystem processes of this community. Grazing by domestic livestock also occurs. Overgrazing may have resulted in major long-term shifts in vegetation composition and structure, serious disturbance to the soil surface, and spread of invasive species (Fleischner 1994).

Fragility

Moderately to highly fragile. Soils, especially the finer-textured types, are susceptible to degradation from trampling, compaction, and erosion. Vegetation can recover after forest harvesting, but could take a long time to return to old growth condition in the dry hot climate with occasional periods of drought. It will take even longer for these plant communities to recover from chronic overgrazing. Unfortunately, early succession will probably be dominated by invasive species that will persist. These ecosystems are very susceptible to invasion by invasive species.

Conservation and Management

Status

The ponderosa pine/bluebunch wheatgrass–silky lupine plant community is on the provincial *Red List* in British Columbia. In the province, this community is ranked S2. No comparable community has yet been identified in adjacent jurisdictions.

Trends

Not much of this community remains in relatively undisturbed, old growth, high quality condition. It is in poor condition virtually over its entire range and very few (<20) high quality occurrences remain (i.e., large stands of old open forest, relatively undisturbed—not logged, not or lightly grazed by domestic livestock, without invasive species, and free of the dense coniferous ingrowth that results from fire exclusion). It is expected to continue to decline due to fire prevention and suppression, forest harvesting, rural development, poor range practices, and the spread of invasive species.

Threats

The PPdh is a small subzone with a history of disturbance by humans. Although humans have had a rather low population density in the area, post-settlement populations have had a large impact due to widespread and extensive overgrazing and forest harvesting, localized agriculture, urbanization, and mining. In addition, fire suppression results in dense regeneration and ingrowth of young conifers, replacement of ponderosa pine by Douglas-fir, and an unnatural disturbance regime. Poor range practices of the past and recreational activities have resulted in soil disturbances, facilitating the spread of invasive species. This in turn has altered the understorey composition, reducing the cover of native grasses and forbs. Climate change may also be a threat.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those occurring within protected areas and parks.

No occurrences are known to occur within protected areas. Almost none (<0.2%) of the 84 200 ha PPdh is protected. Three small parks (Johnstone Creek, Rock Creek, Wasa Lake: total area 155 ha) exist in the PPdh, but these would offer little protection as they are small and heavily used.

It is unlikely that the riparian management area provisions would apply to most of the occurrences. Old growth management areas (OGMAs) could address, at least in part, some occurrences. However, current policy restricts the placement of OGMAs to the non-timber harvesting land base unless old forest retention objectives cannot be met in the non-timber harvesting land base. At this time it is not known how many occurrences are within that land base.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Within its range, this plant community previously formed the matrix ecosystem in which grasslands and smaller patch moist forests and riparian systems co-occurred. It was the most common and widespread community type of the Ponderosa Pine biogeoclimatic zone in eastern British Columbia and may have covered as much as 40 000 ha. Relatively undisturbed remaining occurrences are mostly small, fragmented, and sparsely distributed. It is recommended to:

❖ re-establish periodic understorey fire as an ecological factor conditioning stands;

❖ control forest ingrowth and encroachment;

❖ maximize connectivity of old forest within the PPdh1 and PPdh2;

❖ maintain or recover at least 20 occurrences in good condition across the range of the plant community. Maintain all of the remaining stands >250 years and recruit younger stands to provide recruitment for older forest;

❖ maintain or restore occurrences to as close to natural condition as possible and practical; and

❖ wherever possible, protect remaining occurrences through the placement of old growth management areas.

Wildlife habitat area

Goal

Maintain or recover known occurrences that could not be addressed through landscape level planning and the designation of old growth management areas.

Feature

Establish WHAs at occurrences that have been confirmed by a registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologists. Priority for WHAs should be any old or mature (structural stage 6 and 7) occurrences of this community that are >10 ha and in a relatively natural state. As a lower priority, establish WHAs within younger forests (stage 5) originating from natural disturbance events, and allow succession to climax condition. Select areas that are (in order of priority):

- the oldest, most structurally complex secondary forests available, ideally stands containing a component of veteran ponderosa pine and Douglas-fir;
- relatively lightly damaged and can be expected to recover to a more natural state;
- part of a network of reserve areas; and
- adjacent to natural occurrences of other plant communities.

Size

The size of the WHA should be based on the extent of the plant community occurrence. WHAs may be ~30–50 ha when in relatively pure composition, or where recovery is the main objective. However, WHAs may be larger (~200 ha) when the understorey community or tree layer has a patchy distribution or when the community occurs in complexes with other at-risk plant communities.

Design

The WHA should include the entire occurrence of the plant community plus ~100 m around the perimeter of the occurrence. Wherever possible, use geographic or topographic boundaries. If boundaries are limited due to some artificial barrier such as roads, rights of way, developed areas, then increase the size at other sections of the boundaries. Minimize edge, unless occurrences are narrow, such as along ridge tops. In these cases, include occurrence plus 200 m around the perimeter of the plant community occurrence. Boundaries should be designed to minimize invasive species.

General wildlife measures

Goals

1. Maintain or restore plant community to a natural state (i.e., same species composition, physical structure, and ecological processes as natural examples of the plant community) (Brayshaw 1970; McLean 1970; Braumandl and Curran [compilers and editors] 1992).
2. Maintain or enhance open savannah old forest structure (i.e., some large old trees, range of tree sizes, large snags, down logs) (Spies 1998).
3. Maintain a diversity of natural disturbance regimes.
4. Allow for the processes of litter accumulation, renewal, and microbiotic crust development.
5. Prevent physical disturbance, especially of the soil.
6. Maintain native grass-dominated ground cover.
7. Minimize the introduction and spread of invasive species.

Measures

Access

- Do not develop roads or trails.

Harvesting and silviculture

- Do not harvest or salvage except when required to create a windfirm edge or when approved by the statutory decision maker.
- Do not remove non-timber forest products.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing (timing, level of use, distribution) to meet general wildlife measure goals above. Fencing could be required by the statutory decision maker to meet goals, to recover community, or for restoration treatments.
- Maintain an average stubble height for bluebunch wheatgrass of at least 22 cm.
- Do not place livestock attractants within WHA.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation, soils, and hydrology when operating adjacent to a WHA, particularly during road development and maintenance.

This community is part of broader fire-maintained ecosystems, which have been subject to fire suppression and consequent forest encroachment and ingrowth (Arno et al. 1995; Gayton 1996; Hardy and Arno [editors] 1996; RMTER 2000). Key to restoring this community is to emulate the effects of this former natural fire regime, by establishing restoration silvicultural treatments (such as limbing to prevent surface fires from crowning) and light intensity, prescribed burns in the fall (Thomson 1988; Arno et al. 1995; Zlatnik 1999a, 1999b). Maintain and restore saskatoon, bluebunch wheatgrass, Idaho fescue, and balsamroot cover; cycles of litter and biotic crust accumulation and light intensity natural fire renewal. Increase cover and diversity of other native species (e.g., forbs, rough fescue) and maintain open savannah to open forest structure (e.g., 15–30% cover) of older (e.g., >150 year old) ponderosa pine and Douglas-fir trees.

Light to moderate grazing/browsing and periodic renewal are necessary as part of the disturbance regime for this community, but higher levels can cause the loss of the community through shifts in competition-mediated shifts in composition and species invasions (McLean and Marchand 1968; Ross 1997). In addition, the key species of the community still have susceptibilities to higher burn intensities in different seasons (Thomson 1988; Zlatnik 1999a, 1999b). Using light intensity prescribed burns in fall ‘is a compromise between these susceptibilities and the difficulties of a spring burn window before the onset of bunchgrass growth. Burns should be able to be carried out under a regular burn plan, plus species-level monitoring, without the need for a specific site management plan. Silvicultural treatments should leave older trees and snags, which have an important role for wildlife of open savannah and open forests.

Restrict recreational use (i.e., dirt bikes, mountain bikes, and other off-road vehicles).

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Mapping and assessment of the structural stage, successional dynamics, quality, and integrity of the remnant occurrences.
3. Identification of candidate forests for recruitment.

Cross References

Bighorn Sheep, Flammulated Owl, Fringed Myotis, “Great Basin” Gopher Snake, “Interior” Western Screech-Owl, Lewis’s Woodpecker, Spotted Bat, White-headed Woodpecker

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Western Hemlock–Douglas-fir/Electrified Cat's-tail Moss

Tsuga heterophylla–Pseudotsuga menziesii/Rhytidiadelphus triquetrus

Original prepared by J. Pojar, S. Flynn, and C. Cadrin

Plant Community Information

Description

This forest community has a canopy composed primarily of western hemlock (*Tsuga heterophylla*) and Douglas-fir (*Pseudotsuga menziesii*), with a lesser component of western redcedar (*Thuja plicata*). The shrub layer is rather sparse and not vigorous, with low cover of falsebox (*Paxistima myrsinites*), red huckleberry (*Vaccinium parvifolium*), black huckleberry (*Vaccinium membranaceum*), baldhip rose (*Rosa gymnocarpa*), and sometimes dull Oregon-grape (*Mahonia nervosa*). Twinflower (*Linnaea borealis*), queen's cup (*Clintonia uniflora*), and prince's pine (*Chimaphila umbellata*) dominate the moderately diverse herb layer. Other common herbs include rattlesnake-plantain (*Goodyera oblongifolia*), pink wintergreen (*Pyrola asarifolia*), one-sided wintergreen (*Orthilia secunda*), sword fern (*Polystichum munitum*), and bracken fern (*Pteridium aquilinum*). The moss layer is dominated by step moss (*Hylocomium splendens*), pipecleaner moss (*Rhytidiopsis robusta*), electrified cat's-tail moss (*Rhytidiadelphus triquetrus*), and red-stemmed feathermoss (*Pleurozium schreberi*). See Green and Klinka (1994).

Zonal sites in the CWHds1. These forests occur mostly on middle slopes and higher terraces, on a variety of surficial deposits and on moderately well-drained soils with a range of textures, but tending to coarse-loamy rather than fine-loamy. Sites have medium to poor nutrient regime and fresh to somewhat dry soil moisture (relative within subzone).

Distribution

Global

Unknown.

British Columbia

In British Columbia, this community occurs in the drainages of the lower Fraser River east and north of Chilliwack, and in the eastern portion of the Coast/Cascade Mountains from upper Harrison Lake to the Homathko River. It also occurs in submaritime and subcontinental areas north of the head of Knight Inlet, especially in the lower Klinaklini, Bella Coola, Talchako, and Dean valleys.

Forest regions and districts

Coast: Chilliwack, North Island, Squamish, Sunshine Coast

Southern Interior: Cascades, Chilcotin

Ecoprovinces and ecosections

CEI: WCR

COM: CPR, EPR, NPR, SPR

SOI: LPR

Biogeoclimatic unit

CWH: ds1/01, ds2/01

Broad ecosystem unit

CW

Elevation

Near sea level to 650 m

Plant Community Characteristics

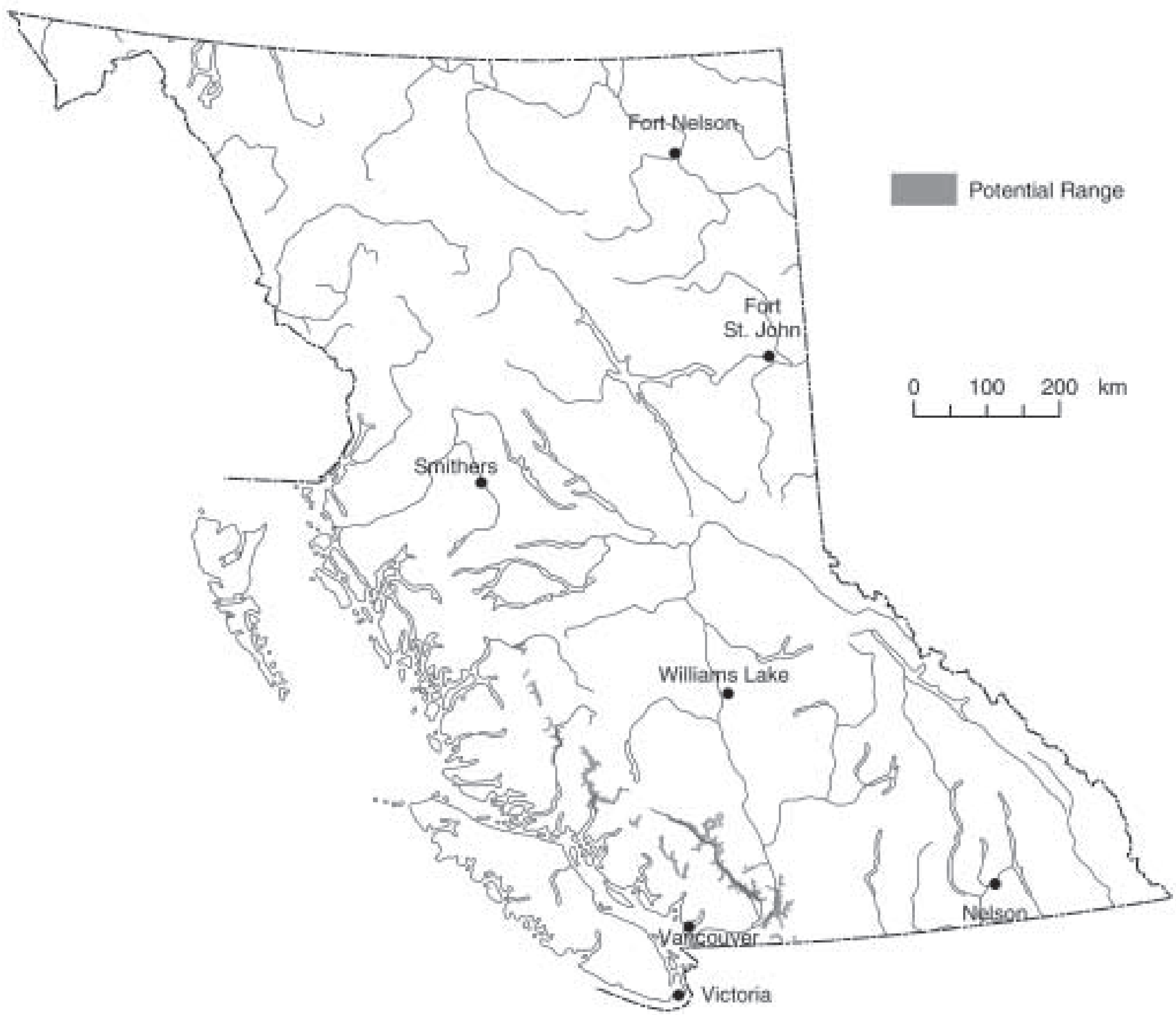
Structural stage

6: mature forest

7: old forest

Western Hemlock - Douglas-fir / Electrified Cat's-tail Moss

(Tsuga heterophylla - Pseudotsuga menziesii / Rhytidiadelphus triquetrus)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

Natural disturbance regime

Infrequent stand-initiating events (NDT2) (MOF and MELP 1995), primarily wildfire (perhaps every 200–300 years, on average) and windthrow, sometimes snow avalanches and landslides. Occasional direct mortality of individual or small groups of trees due to defoliating insects and root rots, or indirect mortality via predisposition of attacked trees to blowdown (see Pojar et al. 1999). Gap dynamics prevail in old forests.

Fragility

Low to moderate. Soils typically are deep, somewhat coarse-textured with a medium to poor nutrient regime. This plant community sometimes occurs on unstable landforms, and could be susceptible to mass movements, especially those triggered by forestry activity such as road building. It should also recover relatively quickly after stand-destroying disturbances, provided biological legacies such as snags and large downed logs persist on site. However, the transitional (i.e., between coast and interior) nature of the climate is reflected in periodic climatic extremes (summer drought, cold air ponding, outflow winter winds, heavy snows). The climatic factors can delay forest regeneration and could slow recovery after disturbance.

Conservation and Management

Status

The western hemlock–Douglas-fir/electrified cat's-tail moss plant community is on the provincial *Red List* in British Columbia. It is ranked S2 in British Columbia. Its global status is unknown.

Trends

Exact calculations of the areal extent of this once predominant forest system are difficult to project. By definition, the zonal forest type of each biogeo-climatic subzone is the expression of the dominant landscape and climatic conditions and frequently represents the largest area, proportionally, of all ecosystems within the subzone. However, this plant community has been heavily logged over much of its range, and continues to be logged. Urban and agricultural developments have also impacted this plant community. Timber harvesting of remaining patches of old and mature forest will continue, as will localized urban development. Large old or mature, high quality occurrences are now rare.

Threats

Primarily threatened by forest harvesting and the resulting loss and fragmentation of sizeable, old, high quality occurrences. Agricultural, rural, and urban development (Fraser Valley, Pemberton Valley, Bella Coola Valley) have also reduced the occurrence of this plant community.

The greatly diminished connectivity of old forest in the CWHds is a serious issue in the valleys, especially at the lower elevations typically occupied by this subzone. Most of the remaining patches of old growth outside of parks are fragments in a matrix of younger second growth.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those within protected areas and parks.

Known sites occur within several provincial parks including Tweedsmuir (especially along middle Dean River and on east side of Talchako River), Homathko, Mehatl, Chilliwack Lake, Skagit Valley, Garibaldi, and Birkenhead Lake.

Riparian management area guidelines are unlikely to be relevant for most occurrences of this plant community. Old growth management areas could address, at least in part, some occurrences provided old forest objectives cannot be met in the non-timber harvesting land base.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

This matrix forest community used to be widespread, forming the predominant forest matrix throughout much of its range. It is recommended to:

- ❖ maximize connectivity of old forest within the CWHds1;
- ❖ maintain or recover at least 20 large occurrences in good condition across the range of the plant community;
- ❖ maintain or restore occurrences to as close to natural condition as possible and practical; and
- ❖ wherever possible, protect remaining occurrences through the placement of old growth management areas.

Wildlife habitat area

Goals

Maintain or recover known occurrences that could not be addressed through landscape level planning and the designation of old growth management areas.

Feature

Establish WHAs at occurrences that have been confirmed by a registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologists. Priority for WHAs should be any old (structural stage 7) occurrences of this community and include within a matrix of younger stands if necessary to attain a 40 ha minimum size that and mature (structural stage 6) occurrences >100 ha that are in a relatively natural state. As a lower priority, establish WHAs up to 100 ha within regenerating younger forests containing the same plant community, to recover community to climax condition. Select areas that are (in order of priority):

- the oldest, most structurally complex secondary forests available, ideally stands containing some old residual conifers;
- relatively lightly damaged and can be expected to recover to a more natural state;
- part of a network of reserve areas (e.g., adjacent or linked to other WHAs or to OGMAs or to riparian reserves);
- in areas where the forest community has been severely depleted; and
- adjacent to natural occurrences of other plant communities.

Size

The size of the WHA should be based on the extent of the plant community occurrence. Typically occurrences of this plant community are a minimum of 40 ha.

Design

The WHA should include the entire occurrence of the community plus ±100 m (approximately two tree heights) surrounding the community. Boundaries should be designed to minimize edge effects and be windfirm.

General wildlife measures

Goals

1. Maintain or restore plant community to a natural state (i.e., same species composition, physical structure, and ecological processes as natural examples of the plant community; see Green and Klinka 1994).
2. Maintain or enhance old forest structure (i.e., large old trees, range of tree sizes, large snags, down logs, canopy depth and roughness, multiple vegetation strata, horizontal patchiness of understorey) (Spies 1998).
3. Maintain forest-interior conditions.
4. Prevent physical disturbance, especially of the soil.
5. Minimize introduction and spread of non-native species.

Measures

Access

- Do not develop roads or trails.

Harvesting and silviculture

- Do not harvest or salvage except when required to create a windfirm edge.
- Do not remove non-timber forest products.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation, soils and hydrology when operating adjacent to a WHA, particularly during road development and maintenance.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Mapping of present-day occurrences and assessment of structural stage and successional dynamics of the occurrences.
3. Identification of the most optimal networks to link this and other listed communities in the CWHds1.

Cross References

Spotted Owl

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Western Redcedar/Devil's-club/Ostrich Fern

Thuja plicata/Oplopanax horridus/Matteuccia struthiopteris

Original prepared by J. Pojar, S. Flynn, and C. Cadrin

Plant Community Information

Description

This moist forested community has a canopy dominated by western redcedar (*Thuja plicata*), with some hybrid white spruce (*Picea engelmannii* × *glauca*), subalpine fir (*Abies lasiocarpa*), black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), and paper birch (*Betula papyrifera*). The shrub layer is dominated by devil's-club (*Oplopanax horridus*), and has a moderate cover of thimbleberry (*Rubus parviflorus*). Black gooseberry (*Ribes lacustre*) and Douglas maple (*Acer glabrum*) are also present, typically with low cover. The dense herb layer is dominated by oak fern (*Gymnocarpium dryopteris latifolia*), one leaved-foamflower (*Tiarella trifoliata* var. *unifoliata*), enchanter's-nightshade (*Circaea alpina*), and toothed wood fern (*Dryopteris carthusiana*). Ostrich fern (*Matteuccia struthiopteris*), lady fern (*Athyrium filix-femina*), common miterwort (*Mitella nuda*), and meadow horsetail (*Equisetum pratense*) are present with moderate cover. Coastal leafy moss (*Plagiomnium insigne*) dominates the poorly developed moss layer. See Meidinger et al. (1984, 1988) and DeLong et al. (1996) for detailed descriptions.

This community occupies lower, toe, and level slope positions with medium- to coarse-textured (coarse loamy to sandy) fluvial deposits. Sites are usually on or near floodplains and subject to seepage and periodic flooding. Most commonly they are middle and high bench fluvial terraces. Soils are moist to very moist (relative within subzone) with imperfect to poor drainage, and have a medium to rich nutrient regime.

Distribution

Global

Western redcedar/devil's-club/ostrich fern is restricted to British Columbia, and reportedly occurs only in the ICHvk2, a rather small (ca. 113 640 ha) variant in east-central British Columbia.

British Columbia

This community is sparsely distributed as small patches on lower valley walls along the Fraser River between Dome Creek and the Bowron River, above Slim Creek between the Fraser River and Tumuch Lake, and above Walker Creek/Goodson Creek between the McGregor and Torpy rivers. It can also be found on southwest aspects above the McGregor River between Mount Sir Alexander and Gleason Creek, and along the Torpy River on the lower slopes of the McGregor Range and Bearpaw Ridge.

Forest region and district

Northern Interior: Prince George

Ecoprovinces and ecosections

SBI: MCP, SHR
SIM: BOV, CAM, UFT

Biogeoclimatic unit

ICH: vk2/05

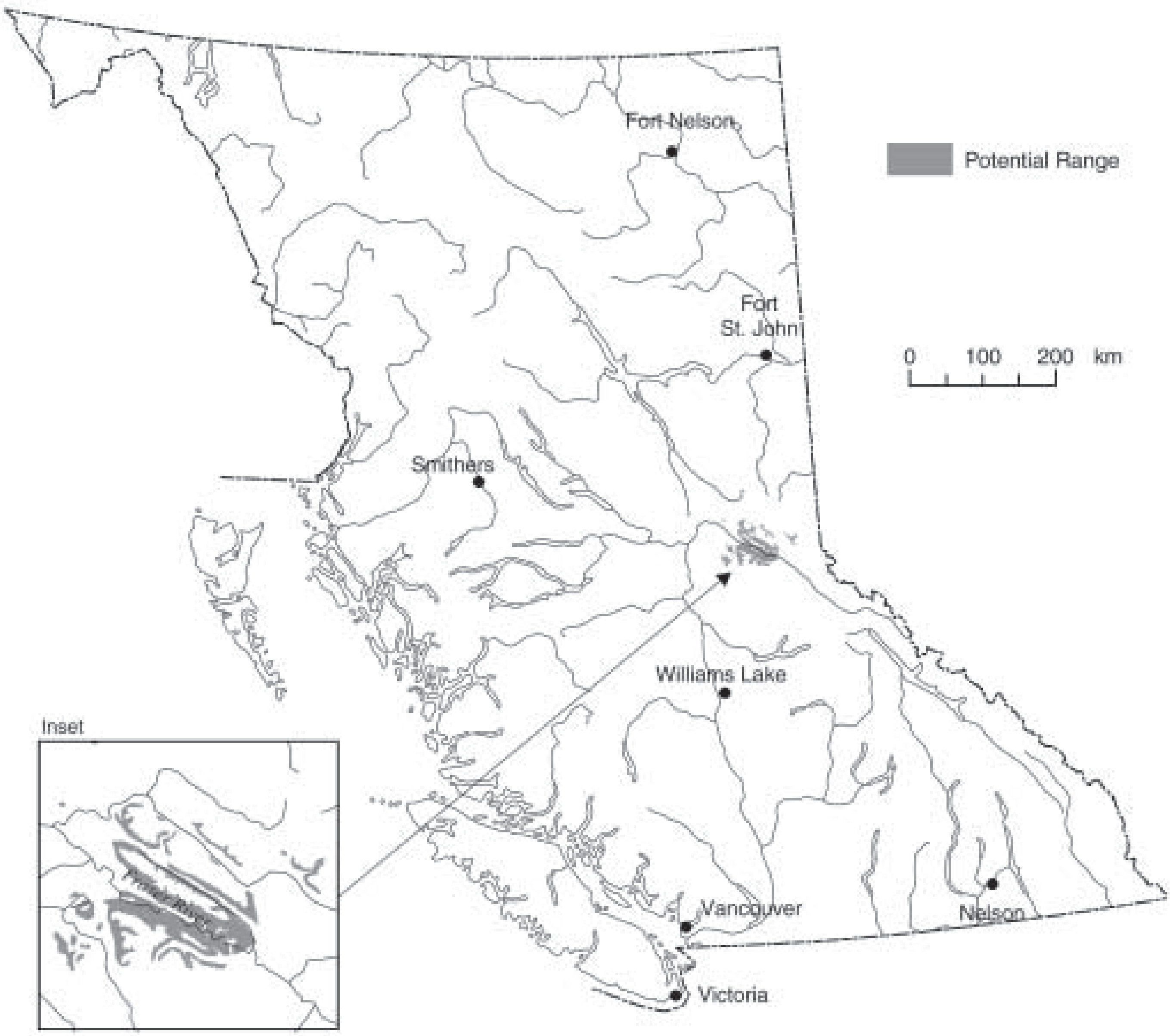
Broad ecosystem units

IH, RR

Elevation

680–1000 m

Western Redcedar / Devil's-club / Ostrich Fern
(Thuja plicata / Oplopanax horridus / Matteuccia struthiopteris)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

Plant Community Characteristics

Structural stage

6: mature forest (more structurally complex stands, usually >150 years)
7: old forest (>250 years)

Natural disturbance regime

Rare stand-initiating events (NDT1) (MOF and MELP 1995) including wildfire (although these valley bottom forests are less likely to burn than those on adjacent uplands), major floods, insect epidemics (e.g., hemlock looper [*Lambdina fiscellaria*] and green-striped forest looper [*Melanolophia imitate*], although they attack western hemlock primarily), and windthrow. Fairly frequent direct mortality of individual or small groups of trees due to root rots, defoliating insects, and bark beetles, or indirect mortality via predisposition of attacked trees to blowdown.

Fragility

Very fragile. Soils typically are deep, medium- to coarse-textured, moist to very moist, and at least moderately nutrient rich. Hence these sites are less susceptible than finer-textured poorer sites to degradation due to soil compaction, erosion, and nutrient losses. However, their valley bottom location makes these ecosystems obvious targets for road locations and harvesting. The soils are imperfectly to poorly drained and have at least periodically high water tables, and sometimes occur on unstable materials, so are susceptible to water table changes and to small mass movements, especially those triggered by land clearing or forestry activity such as road building. Overbank floods occur occasionally, but are part of the natural hydrological regime. The ecosystems rebound vigorously after stand-destroying disturbances. But they take a long time (two to three centuries at least) to attain old-growth conditions, and will do so within the lifetime of a redcedar tree only if biological legacies such as snags and large downed logs persist on site. These rich moist sites are also prone to outbursts of shrubbery and to growing season frosts after major disturbances, which can result in deciduous "brush" competition with conifers, delays in forest regeneration, and slower forest recovery after disturbance.

Conservation and Management

Status

The western redcedar/devil's-club/ostrich fern plant community is on the provincial *Red List* in British Columbia. In British Columbia this community is ranked S1S2. Its global status is proposed as G1G2.

Trends

Perhaps stable for now. Ecologists estimate that <10 high quality occurrences remain. The community was probably always rare but has been seriously depleted and its old structural stage is in peril. Further decline may now be arrested due to some new protected areas and riparian management guidelines. But the trend is uncertain and, with so few occurrences, the risk of losing these old floodplain forests is very high. Although, the distribution of this community has probably always been patchy and dynamic, few old patches now remain and few young patches are being recruited.

Threats

This community is naturally rare within a small range, and typically occurs in small patches or strips. The fairly high timber values of the ICHvk2 in general (including the ICHvk2/05) have resulted in serious depletion of this community by logging. Parts of the subzone (including some of this community) have been cleared for ranching, forest harvesting and minor human settlement on small parcels of private land. The subzone is bisected by the transportation corridor of the CN Railway and Highway 16; the railroad in particular has affected these valley bottom ecosystems. Connectivity of old forest habitat is a serious conservation issue, especially along the major riparian corridors where this plant community occurs.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those occurring within protected areas and parks.

Some representation in Sugarbowl–Grizzly Den, Slim Creek, and perhaps Kakwa parks. The ICHvk2 as a whole has 10% (10 926 ha) of its area protected, but not much of that total would include this restricted and rare community.

The *Forest Practices Code* guidelines for riparian management areas presumably would apply to most of the occurrences, but could be too narrow to provide adequate protection. Old growth management areas may protect some occurrences provided old forest retention objectives cannot be met in the non-timber harvesting land base.

Identified Wildlife Provisions

Strategic management recommendations

- ❖ Maintain water flow and hydrological system of the surrounding landscape. The occurrence of this community as a linear system dependent on adjacent water flows and upland drainage requires consideration of the larger landscape context.
- ❖ Maximize connectivity of riparian systems and upland/riparian linkages within the ICHvk2.
- ❖ Maintain or recover at least 20 occurrences in good condition across the range of the plant community.
- ❖ Maintain or restore occurrences to as close to natural condition as possible and practical.
- ❖ Wherever possible, protect remaining occurrences through the placement of old growth management areas and riparian management guidelines.

Wildlife habitat area

Goals

Maintain or recover known occurrences that could not be addressed through landscape level planning and the designation of old growth management areas.

Feature

Establish WHAs at occurrences that have been confirmed by a registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologists. Priority for WHAs should be any old (structural stage 7) occurrences within a young stand of sufficient stream length and upland buffering to attain a minimum of 5 ha or any mature (structural stage 6) linear occurrences in a relatively natural state and where the watercourse is undisturbed for a significant upstream distance. As a lower priority, establish WHAs within younger, relatively undisturbed forests including this plant community to recover the community to climax condition along stable river systems. Select areas that are or have (in order of priority):

- the oldest, most structurally complex secondary forests available;
- intact hydrological processes that are relatively lightly damaged and can be expected to recover to a more natural state;
- part of a network of reserve areas; and
- adjacent to natural occurrences of other plant communities.

Size

The size of the WHA should be based on the extent of the plant community occurrence. Typically occurrences of this plant community are between 5 and 50 ha.

Design

The WHA should include the entire occurrence of the community plus ±100 m (approximately two tree heights) surrounding the occurrence along the upland boundary of the stream. Boundaries should be designed to minimize edge effects and to the extent possible, be delineated along windfirm boundaries. Typically the trees on these sites have shallow rooting, and the stands are prone to windthrow.

General wildlife measures

Goals

1. Maintain or restore plant community to a natural state (i.e., same species composition, physical structure, and ecological processes as natural examples of the plant community; see Meidinger et al. 1984; DeLong et al. 1996).
2. Maintain or enhance old forest structure (i.e., large old trees, range of tree sizes, large snags, down logs, canopy depth and roughness, multiple vegetation strata, horizontal patchiness of understorey) (Spies 1998).
3. Maintain or restore the natural hydrological regime of the WHAs. Seepage, fluctuating and seasonally high water tables, and occasional major overbank floods are fundamental to the ecology of these riparian ecosystems.
4. Maintain open forest-interior conditions.
5. Prevent physical disturbance, especially of the soil.
6. Minimize introduction and spread of invasive species.

Measures

Access

- Do not develop roads or trails.

Harvesting and silviculture

- Do not harvest or salvage except when required to create a windfirm edge.
- Do not remove non-timber forest products.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation, soils, and hydrology when operating adjacent to WHA. These considerations apply particularly to land clearing, and road location, construction, and maintenance.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Mapping and assessment of the structural stage, successional dynamics, quality, and integrity of the remnant occurrences.
3. Identification of candidate forests for recruitment.

Cross References

Bull Trout, Fisher, Grizzly Bear

References Cited

B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks (MOF and MELP). 1995. Biodiversity guidebook. Victoria, B.C. Forest Practices Code of B.C. guidebook.

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Western Redcedar–Douglas-fir/Devil's-club

Thuja plicata–Pseudotsuga menziesii/Oplopanax horridus

Original prepared by J. Pojar, S. Flynn, and C. Cadrin

Plant Community Information

Description

This forest community is dominated by western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*), often accompanied by Douglas-fir (*Pseudotsuga menziesii*) and (in the central coast) Sitka spruce (*Picea sitchensis*). Devil's-club (*Oplopanax horridus*) characterizes the rather sparse shrub layer. The herb layer is dominated by queen's cup (*Clintonia uniflora*), lady fern (*Athyrium filix-femina*), spiny wood fern (*Dryopteris expansa*), rosy twistedstalk (*Streptopus roseus*), and oak fern (*Gymnocarpium dryopteris latifolia*). Step moss (*Hylocomium splendens*), electrified cat's-tail moss (*Rhytidiadelphus triquetrus*), coastal leafy moss (*Plagiomnium insigne*), and lanky moss (*Rhytidiadelphus loreus*) are common mosses. See Green and Klinka (1994).

These forests occur at low elevations; on lower or level slope positions; and on fluvial, colluvial, and sometimes morainal deposits. Soils are moderately well drained but often exhibit seepage, and are loamy or sandy, frequently with many coarse fragments. Sites are moist to very moist (relative within subzone), and nutrient conditions are rich to very rich.

Distribution

Global

Unknown.

British Columbia

In British Columbia, this community occurs in the drainages of the lower Fraser River east and north of Chilliwack and in the eastern portion of the Coast/Cascade Mountains from upper Harrison Lake to the Homathko River. It also occurs in submaritime and subcontinental areas north of the head of Knight Inlet, especially in the lower Klinaklini, Bella Coola, Talchako, and Dean valleys.

Forest regions and districts

Coast: Chilliwack, North Island, Squamish, Sunshine Coast

Southern Interior: Cascades, Chilcotin

Ecoprovinces and ecosections

CEI: WCR
COM: CPR, EPR, NPR, SPR
SOI: LPR

Biogeoclimatic unit

CWH: ds1/07

Broad ecosystem unit

CW

Elevation

Near sea level to 650 m

Plant Community Characteristics

Structural stage

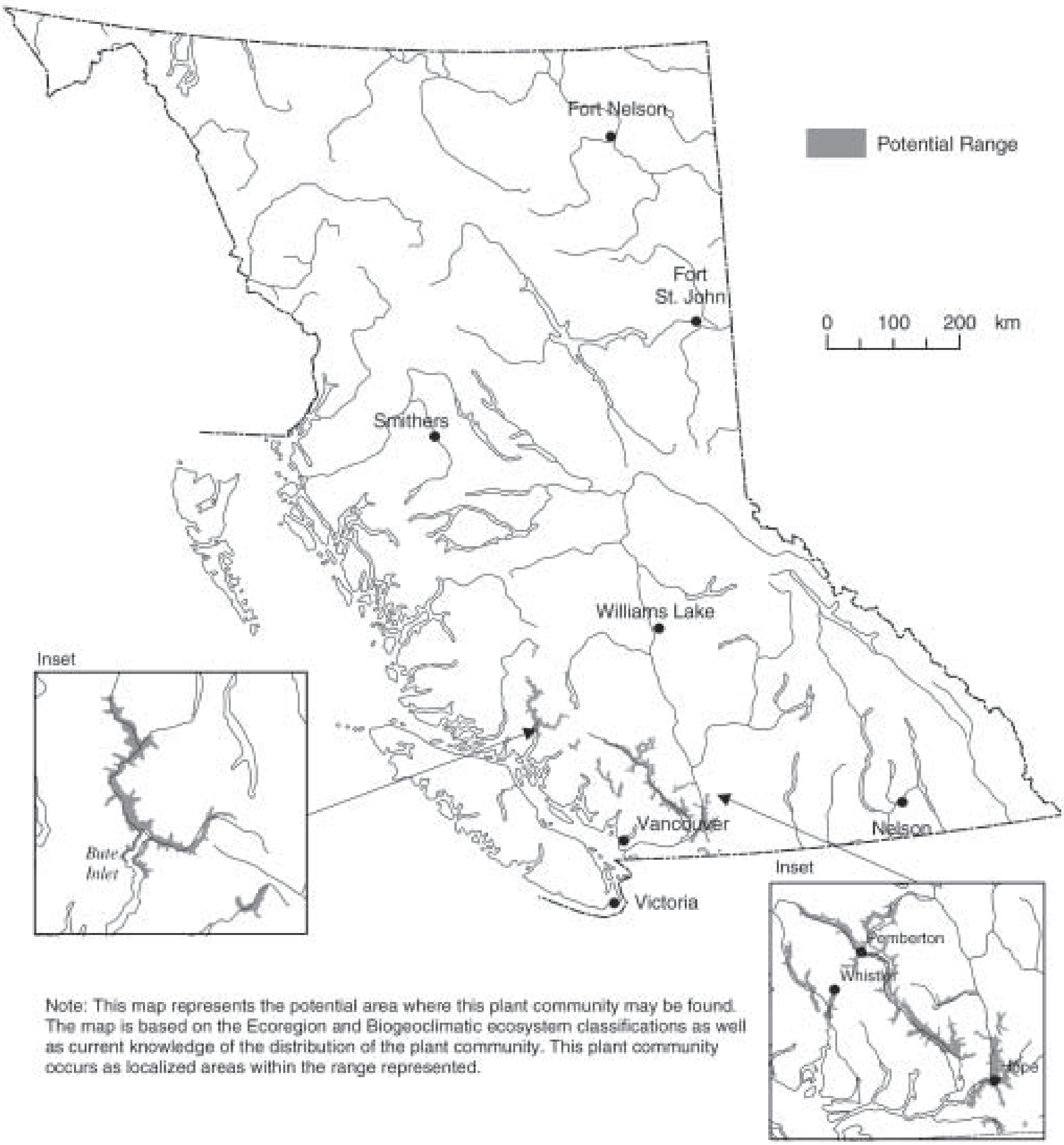
6: mature forest
7: old forest

Natural disturbance regime

Infrequent stand-initiating events (NDT2) (MOF and MELP 1995), primarily wildfire (perhaps every 200–300 years, on average) and windthrow, sometimes snow avalanches and landslides. Occasional

Western Redcedar - Douglas-fir / Devil's-club

(Thuja Plicata - Pseudotsuga menziesii / Oplopanax horridus)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

direct mortality of individual or small groups of trees due to defoliating insects and root rots, or indirect mortality via predisposition of attacked trees to blowdown (see Pojar et al. 1999). Gap dynamics prevail in old forests.

Fragility

Low to moderate. Soils typically are deep, somewhat coarse-textured, moist and nutrient-rich. Therefore, these sites are less susceptible to degradation due to soil compaction, erosion, and nutrient losses and should recover relatively quickly after stand-destroying disturbances provided biological legacies such as snags and large downed logs persist on site. However, the transitional (i.e., between coast and interior) nature of the climate is reflected in periodic climatic extremes (summer drought, cold air ponding, outflow winter winds, heavy snows). The climatic factors can delay forest regeneration and could slow recovery after disturbance.

Conservation and Management

Status

The western redcedar–Douglas-fir/devil's-club plant community is on the provincial *Red List* in British Columbia. It is ranked S1S2 in British Columbia. Its global status is unknown.

Trends

The CWHds is a medium-sized subzone with a long history (by B.C. standards) of disturbance by humans. Many forest sites are productive and used to have an abundance of old growth Douglas-fir; thus, timber harvesting has been extensive. This community used to be rather widespread as small patches distributed across a localized area. It has been heavily logged over much of its range, and continues to be logged. Urban and agricultural developments have also impacted this plant community. Timber harvesting of remaining patches of old forest on these productive sites will continue, as will localized developments for other land uses.

Threats

Naturally small and patchy occurrences continue to be threatened by forest management and the resulting loss of high quality mature and old forests and also because of the history of disturbance of these forests and the areas surrounding them. Agriculture, rural, and urban development (Fraser Valley, Pemberton Valley, Bella Coola Valley) have also impacted this plant community.

The greatly diminished connectivity of old forest in the CWHds is a serious issue, especially at the lower elevations typically occupied by this subzone. Most of the remaining patches of old forest outside of parks are patches in a matrix of second growth.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those within protected areas and parks.

Known sites occur within the following provincial parks: Tweedsmuir (especially along middle Dean River and on east side of Talchako River), Homathko, Mehatl, Chilliwack Lake, Skagit Valley, Garibaldi, and possibly Birkenhead Lake.

The *Forest and Range Practices Act* riparian guidelines would most likely not apply to this plant community. Old growth management areas (OGMAs) could address, at least in part, some occurrences provided old forest objectives could not be met in the non-timber harvesting land base.

Identified Wildlife Provisions

Sustainable resources management and planning recommendations

- ❖ Maintain or recover at least 20 occurrences in good condition across the range of the plant community.
- ❖ Maintain or restore occurrences to as close to natural condition as possible and practical.
- ❖ Maximize connectivity of old forest within the CWHds1.
- ❖ Wherever possible, protect remaining occurrences through the placement of OGMAs.

Wildlife habitat area

Goal

Maintain or recover known occurrences that could not be addressed through landscape level planning and the designation of old growth management areas.

Feature

Establish WHAs at occurrences that have been confirmed by a registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologists. Priority for WHAs should be any old (structural stage 7) occurrences of this community within a younger stand if necessary to attain a minimum size of 10 ha and mature (structural stage 6) occurrences between 5 and 50 ha that are in a relatively natural state. As a lower priority, establish WHAs within regenerating younger forests belonging to the same plant community, to recover community to climax condition. Select areas that are (in order of priority):

- the oldest, most structurally complex secondary forests available, ideally stands containing some old residual conifers;
- relatively lightly damaged and can be expected to recover to a more natural state;
- part of a network of reserve areas;
- in areas where the forest community has been severely depleted; and
- adjacent to natural occurrences of other plant communities.

Size

The size of the WHA should be based on the extent of the plant community occurrence. Typically occurrences of this plant community are between 5 and 50 ha.

Design

The WHA should include the entire occurrence of the community plus ±100 m (approximately two tree heights) surrounding the occurrence. Boundaries should be designed to minimize edge effects and to the extent possible, be windfirm.

General wildlife measures

Goals

1. Maintain or restore plant community to a natural state (i.e., same species composition, physical structure and ecological processes as natural examples of the plant community) (see Green and Klinka 1994).
2. Maintain or enhance old forest structure (i.e., large old trees, range of tree sizes, large snags, down logs, canopy depth and roughness, multiple vegetation strata, horizontal patchiness of understorey) (Spies 1998).
3. Maintain a diversity of natural disturbance regimes.
4. Allow for the processes of litter accumulation, renewal, and microbiotic crust development.
5. Maintain forest-interior conditions.
6. Prevent physical disturbance, especially of the soil.
7. Minimize introduction and spread of invasive species.

Measures

Access

- Do not develop roads or trails.

Harvesting and silviculture

- Do not harvest or salvage except when required to create a windfirm edge.
- Do not remove non-timber forest products.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation, soils, and hydrology when operating adjacent to a WHA, particularly during road development and maintenance.

Eventually it will be necessary to intervene in the WHA when large veteran Douglas-fir and Sitka spruce die and are not naturally replaced (both species are shade-intolerant on such sites). The intervention could take the form of fill-planting in a natural gap sufficiently large that full light conditions would occur in part of the opening, or suitable openings could be created through small-group selection logging.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Mapping of present-day occurrences and assessment of structural stage and successional dynamics of the occurrences.
3. Identification of the most optimal networks to link this and other listed communities in the CWHds.

Cross References

Grizzly Bear, Spotted Owl

References Cited

B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks (MOF and MELP). 1995. Biodiversity guidebook. Victoria, B.C. Forest Practices Code of B.C. guidebook.

Green, R.N. and K. Klinka. 1994. A field guide to site identification and interpretation for the Vancouver Forest Region. B.C. Min. For., Victoria, B.C. Land Manage. Handb. No. 28.

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Spies, T.A. 1998. Forest structure: a key to the ecosystem. Northwest Sci. 72:34–39.

Western Redcedar–Douglas-fir/Vine Maple

Thuja plicata–Pseudotsuga menziesii/Acer circinatum

Original prepared by J. Pojar

Plant Community Information

Description

This forest community has a canopy of western redcedar (*Thuja plicata*) and Douglas-fir (*Pseudotsuga menziesii*). Western hemlock (*Tsuga heterophylla*) is usually present, but with low cover and as a subcanopy or suppressed tree, and Pacific yew (*Taxus brevifolia*) can be present, also with low cover. Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), red alder (*Alnus rubra*), and, in the south, bigleaf maple (*Acer macrophyllum*) can persist in mature seral stands. The shrub layer is usually sparse except for regeneration of redcedar and western hemlock, but vine maple (*Acer circinatum*) is locally frequent and often abundant in the south. The herb layer is diverse and characterized by false Solomon's-seal (*Maianthemum racemosum*), clasping twistedstalk (*Streptopus amplexifolius*), queen's cup (*Clintonia uniflora*), wild ginger (*Asarum caudatum*), and one-leaved foamflower (*Tiarella trifoliata* var. *unifoliata*); rattlesnake-plantain (*Goodyera oblongifolia*) and broadleaved starflower (*Trientalis borealis* ssp. *latifolia*) are common. Sword fern (*Polystichum munitum*) and spiny wood fern (*Dryopteris expansa*) are often abundant. The moss layer is dominated by step moss (*Hylocomium splendens*), coastal leafy moss (*Plagiomnium insigne*), Oregon beaked moss (*Kindbergia oregana*), and electrified cat's-tail moss (*Rhytidiadelphus triquetrus*), frequently also with pipecleaner moss (*Rhytidiopsis robusta*). See Green and Klinka (1994).

These forests occur at low elevations, on lower or level slope positions, on colluvial fans and aprons, on fluvial/colluvial fans and upper fluvial terraces, and sometimes on morainal deposits. Soils are moderately well drained but sometimes exhibit seepage or fluctuating water tables, and are sandy or loamy, frequently with lots of coarse fragments. Sites are slightly dry to fresh (relative within subzone), and nutrient conditions are rich to very rich.

Distribution

Global

Unknown.

British Columbia

Western redcedar–Douglas-fir/vine maple occurs in the drainages of the lower Fraser River east and north of Chilliwack, and in the eastern portion of the Coast/Cascade Mountains from upper Harrison Lake to the Homathko River.

Forest regions and districts

Coast: Chilliwack, North Island, Squamish, Sunshine Coast

Southern Interior: Cascades, Chilcotin

Ecoprovinces and ecosections

CEI: CCR, WCR

COM: EPR, KIM, NPR, SPR

SOI: LPR

Biogeoclimatic units

CWH: ds1/05

Broad ecosystem unit

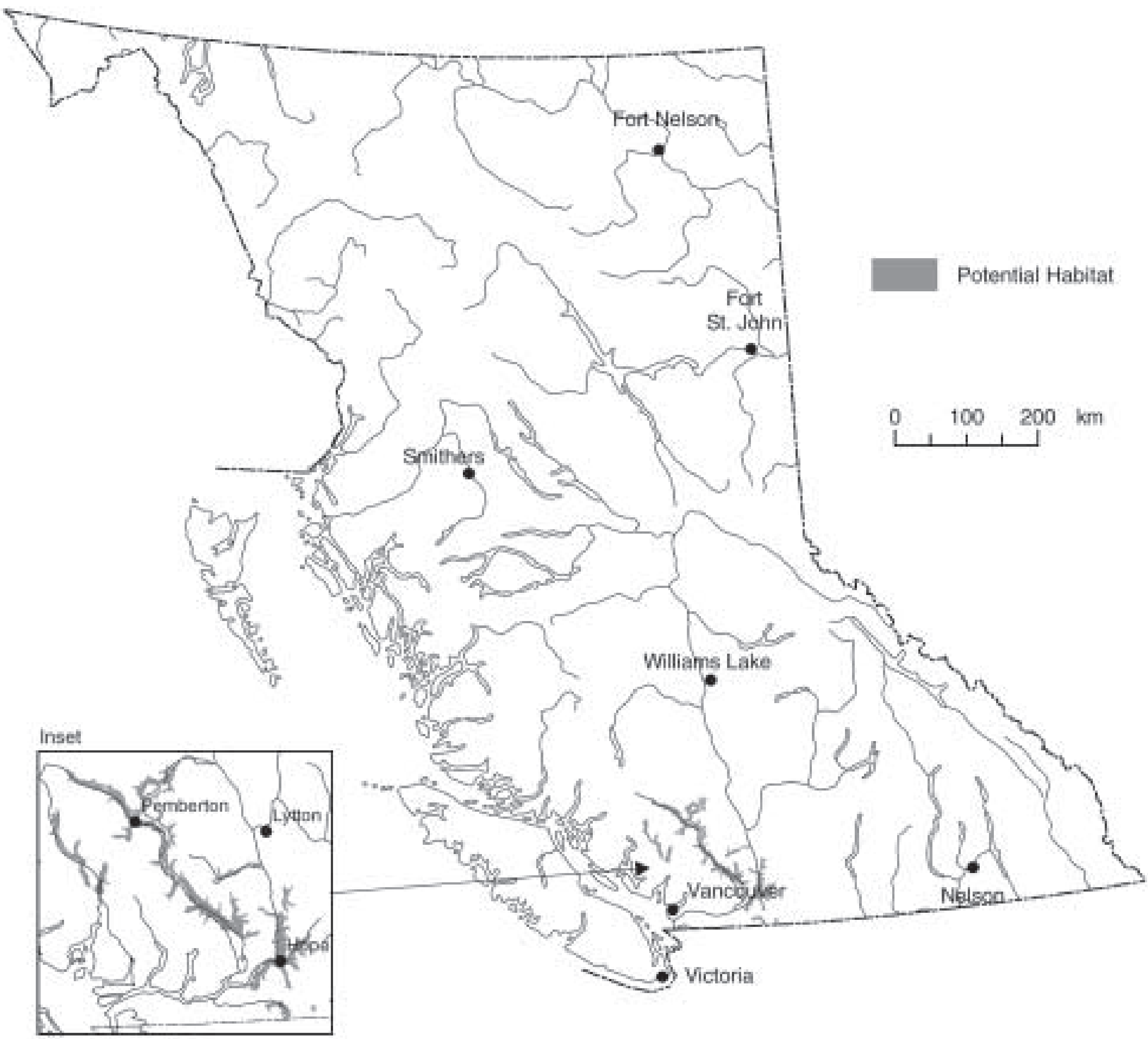
CW

Elevation

Near sea level to 650 m

Western Redcedar - Douglas-fir / Vine Maple

(Thuja plicata - Pseudotsuga menziesii / Acer circinatum)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

Plant Community Characteristics

Structural stage

6: mature forest
7: old forest

Natural disturbance regime

Infrequent stand-initiating events (NDT2) (MOF and MELP 1995), primarily wildfire (perhaps every 200–300 years, on average) and windthrow, sometimes snow avalanches and landslides. Occasional direct mortality of individual or small groups of trees due to defoliating insects and root rots, or indirect mortality via predisposition of attacked trees to blowdown (see Pojar et al. 1999). Gap dynamics prevail in old forests.

Fragility

Relatively robust. Soils typically are deep, somewhat coarse-textured, and nutrient-rich. Hence these sites are less susceptible to degradation due to soil compaction, erosion, and nutrient losses. They do sometimes occur on unstable landforms, however, and could be susceptible to mass movements, especially those triggered by forestry activity such as road building. They should also recover relatively quickly after stand-destroying disturbances, provided biological legacies such as snags and large downed logs persist on site. However, the transitional (i.e., between coast and interior) nature of the climate is reflected in periodic climatic extremes (summer drought, cold air ponding, outflow winter winds, heavy snows). The climatic factors can delay forest regeneration and could slow recovery after disturbance.

Conservation and Management

Status

The western redcedar–Douglas-fir/vine maple plant community is on the provincial *Red List* in British Columbia. It is ranked S1S2 in British Columbia. Its global rank is unknown.

Trends

The CWHds is a moderately sized subzone with a long history (by B.C. standards) of disturbance by humans. Many forest sites are productive with much old-growth Douglas-fir; thus, timber harvesting has been extensive. This plant community was rather widely distributed as small to moderately large patches over a localized area, but has been heavily logged over much of its range, and continues to be logged. It has also been reduced by urban and agricultural developments. Timber harvesting of remaining patches of old growth on these productive sites will continue, as will localized urbanization.

Threats

This plant community is primarily threatened by forest harvesting and consequent rarity of sizeable, old, high quality occurrences. Such high quality occurrences are rare both because they are naturally small, patchy, and heterogeneous, and because of the history of disturbance of these forests and the areas surrounding them. This community is also threatened from agricultural, rural, urban development (Fraser, Pemberton, and Bella Coola valleys) and probably climate change.

The greatly diminished connectivity of old forest in the CWHds is a serious issue, especially at the lower elevations typically occupied by this subzone. Most of the remaining patches of old growth outside of parks are fragments in a matrix of second growth.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those occurring within protected areas and parks.

Several occurrences potentially occur within parks and protected areas including Tweedsmuir (especially along middle Dean River and on the east side of Talchako River), Homathko, Mehatl, Chilliwack Lake, Skagit Valley, Garibaldi, and Birkenhead Lake parks.

The *Forest and Range Practices Act* guidelines for riparian management may not apply to some occurrences of this plant community. Old growth management areas (OGMAs) could address, at least in part, some occurrences provided old forest retention objectives cannot be met in the non-contributing land base. At this time it is not known to what extent OGMAs can address the occurrences of this plant community.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Western redcedar–Douglas-fir/vine maple historically was widely distributed across the lower slopes of both large and small valleys within its range. It occurs as small to large patches, occasionally as linear systems along small creeks and streams. It is recommended to:

- ❖ maintain or recover at least 20 occurrences in good condition across the range of the plant community;
- ❖ maintain or restore occurrences to as close to natural condition as possible and practical;
- ❖ maximize connectivity of old forest within both the CWHds1 and the CWHds2; and
- ❖ wherever possible, protect remaining occurrences through the placement of old growth management areas.

Wildlife habitat area

Goals

Maintain or recover known occurrences that could not be addressed through landscape level planning and the designation of old growth management areas.

Feature

Establish WHAs at occurrences that have been confirmed by a registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologists. Priority for WHAs should be any old (structural stage 7) occurrences >10 ha and mature (structural stage 6) occurrences >50 ha and in a relatively natural state. Old patches should be buffered by younger stands in as natural a condition as possible. As a lower priority, establish WHAs within regenerating younger forests containing the same plant community, to recover community to climax condition. Select areas that are (in order of priority):

- the oldest, most structurally complex secondary forests available, ideally stands containing some old residual conifers;
- relatively lightly damaged and can be expected to recover to a more natural state;
- part of a network of reserve areas;
- in areas where the forest community has been severely depleted; and
- adjacent to natural occurrences of other plant communities.

Size

The size of the WHA should be based on the extent of the plant community occurrence. Typically occurrences of this plant community are between 30 and 200 ha.

Design

The WHA should include the entire occurrence of the community and ~100 m (approximately two tree heights) surrounding the perimeter of the occurrences. Boundaries should be designed to minimize edge effects and to the extent possible, be delineated along windfirm boundaries.

General wildlife measures

Goals

1. Maintain or restore plant community to a natural state (i.e., same species composition, physical structure and ecological processes as natural examples of the plant community; see Green and Klinka 1994).
2. Maintain or enhance old forest structure (large old trees, range of tree sizes, large snags, down logs, canopy depth and roughness, multiple vegetation strata, horizontal patchiness of understorey) (Spies 1998).
3. Maintain interior forest-interior conditions.
4. Prevent physical disturbance, especially of the soil.

5. Minimize introduction and spread of invasive species.

Measures

Access

- Do not develop roads or trails.

Harvesting and silviculture

- Do not harvest or salvage except when required to create a windfirm boundary.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation, soils, and hydrology when operating adjacent to a WHA, particularly during road development and maintenance.

Consider using prescribed fire in larger occurrences that are part of a very large protected area (e.g., Tweedsmuir) to promote natural characteristics.

Consider restoration techniques such as accelerating development of old forest structure or to replace (recruit) shade-intolerant species (e.g., when large veteran Douglas-fir or cottonwood die and are not naturally replaced). Consider fill-planting in a natural gap sufficiently large that full light conditions would occur in part of the opening, or create suitable openings through small-group selection logging.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Mapping of present-day occurrences and assessment of structural stages and successional dynamics of the occurrences.
3. Identification of the most optimal networks to connect this and other listed communities in the CWHds.

Cross References

Grizzly Bear, Spotted Owl, western hemlock–Douglas-fir/electrified cat's-tail moss, western redcedar–Douglas-fir/devil's-club

References Cited

B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks (MOF and MELP). 1995. Biodiversity guidebook. Victoria, B.C. Forest Practices Code of B.C. guidebook.

Green, R.N. and K. Klinka. 1994. A field guide to site identification and interpretation for the Vancouver Forest Region. B.C. Min. For., Victoria, B.C. Land Manage. Handb. No. 28.

Pojar, J., C. Rowan, A. MacKinnon, D. Coates, and P. LePage. 1999. Silvicultural options in the Central Coast. Land Use Coordination Office, Victoria, B.C. Unpubl. report.

Spies, T.A. 1998. Forest structure: a key to the ecosystem. Northwest Sci. 72:34–39.

Water Birch/Red-osier Dogwood

Betula occidentalis/Cornus stolonifera

Original[1] prepared by W.R. Erickson

Plant Community Information

Description

This shrub swamp community has a dense cover of water birch (*Betula occidentalis*) (up to 60% cover), mountain alder (*Alnus incana* ssp. *tenuifolia*) (5–10%), and red-osier dogwood (*Cornus stolonifera*) (7–40%) in the tall shrub layer. Water birch and mountain alder sometimes reach tree height (>10 m). Willows, such as sandbar willow (*Salix exigua*), Scouler's willow (*Salix scouleriana*), Bebb's willow (*Salix bebbiana*), and false mountain willow (*Salix pseudomonticola*), are found as tall shrubs on many sites (7–20% cover). Most sites have poison ivy (*Toxicodendron rydbergii*) as a low shrub (7–10% cover) and roses (*Rosa woodsii* and *Rosa nutkana*) (5–10% cover) as low or tall shrubs. Bittersweet (*Solanum dulcamara*), an introduced climbing vine, is present on many sites.

The herb layer is poorly developed (<10% cover) and variable, but generally contains a low cover of star-flowered false Solomon's seal (*Maianthemum stellatum*), and the introduced Canada thistle (*Cirsium arvense*). A few sites have a notable cover (3–7%) of stinging nettle (*Urtica dioica*) or horsetails (*Equisetum arvense* and *Equisetum hymenales*). There is neither a ground layer nor epiphytes of mosses or lichens in this community.

This community is poorly drained due to a high water table on floodplains. It occupies floodplains on level, depressional-swamp, or raised-levee sites, with a water table near the soil surface. Formed from fluvial (sandy, silty) or organic materials, soils are imperfectly to poorly drained Gleysols (Rego, Orthic, but most frequently, Humic), with organically enriched surface mineral Ah horizons, Typic Humisols, or Cumulic Regosols. It has been assigned a medium to rich nutrient regime and hygric to subhydric ecological moisture regime. Annual accumulation of deciduous plant litter is important in these dense leafy stands. Mountain alder contributes to site nutrition by fixing atmospheric nitrogen, making substantial amounts available for plant growth (Haeussler et al. 1990). These sites are nutrient-rich, productive, and subject to ingress by weedy species.

Sites may have standing water at the soil surface, and are cooled by frost and cold air drainage. This community occurs on middle stream reaches in narrow valleys, which may have a hummocky soil surface.

Distribution

Global

Not known. An equivalent water birch/red-osier dogwood shrubland community occurs or potentially occurs throughout the northwestern United States (California, Idaho, Montana, Oregon, South Dakota, Utah, Washington, Wyoming) (Faber-Langendoen 2001; NatureServe Explorer 2001).

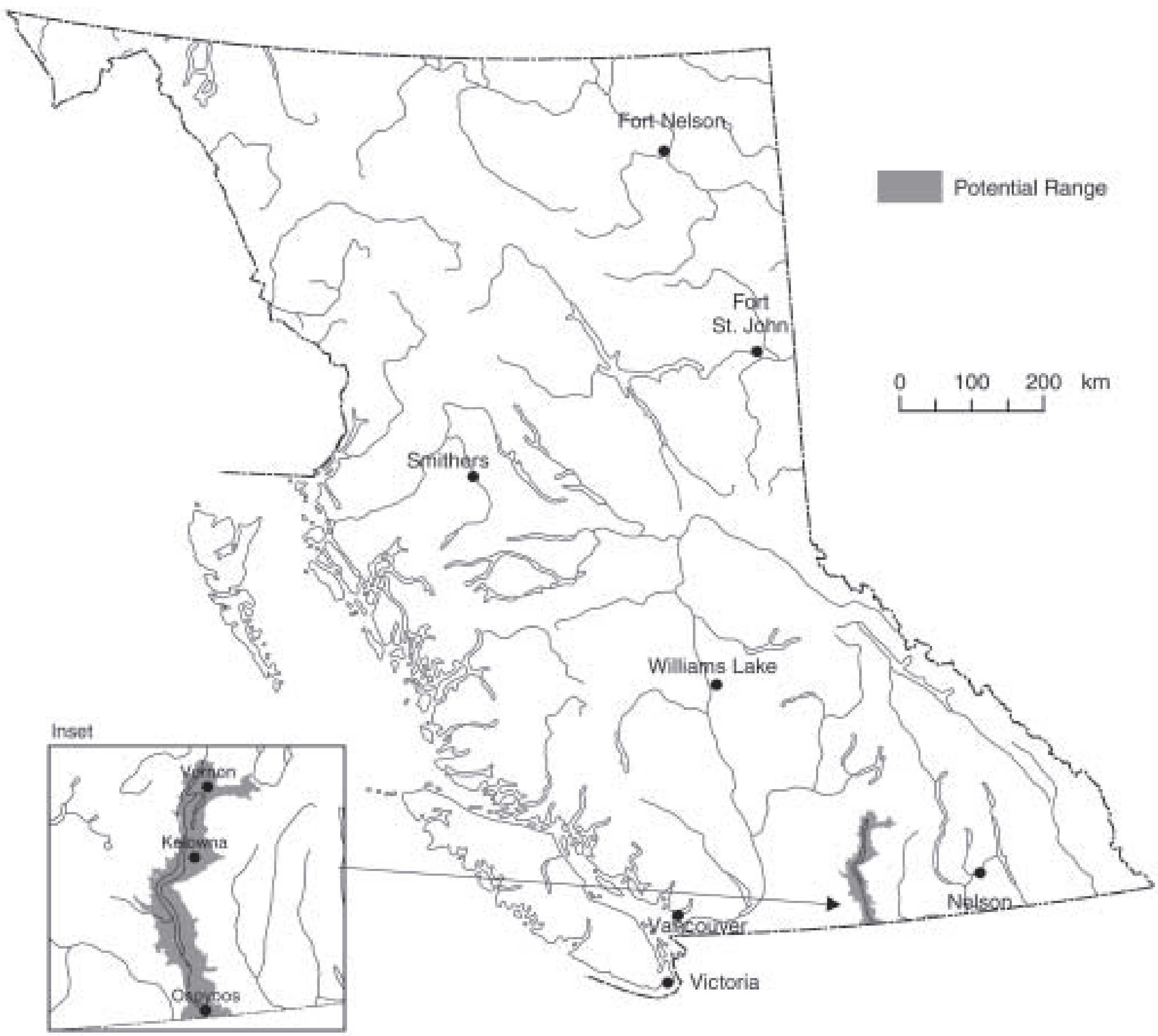
British Columbia

This plant community is restricted to a very small part of the province, occurring in the main valleys and adjacent tributaries south from about Wild Horse Mountain in the Okanagan, and east/south of the confluence of the Ashnola River in the Similkameen Valley. There are isolated occurrences mid-way up some of those tributaries. There are

1 Volume 1 account prepared by S. Flynn and C. Cadrin.

Water Birch - Red-osier Dogwood

(Betula occidentalis - Cornus stolonifera)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

unconfirmed reports of this community in the Merritt and Stump Lake area (J. Kirkby; F. Russell, pers. comm.).

Forest region and districts

Southern Interior: Okanagan Shuswap, Cascades (unconfirmed)

Ecoprovince and ecosections

SOI: NOB, SOB

Biogeoclimatic units

BG: xh1/00

IDF: xh1/00, xh2/00

PP: xh1/00, xh2/00

Broad ecosystem unit

SW

Elevation

250–700 m

Plant Community Characteristics

Structural stage

3b: tall shrub

4: pole–sapling (when shrub layer is >10 m tall)

Natural disturbance regime

Frequent stand-maintaining fires (NDT4 or NDT3) (MOF and MELP 1995). The main natural disturbance at these sites is seasonal flooding. This community is surrounded by other wetland types such as marshes and shallow open water; and is associated with meadow communities and the alluvial complex of Brayshaw (1970). Brayshaw (1970) considered the related communities in the Alluvial Sere as being perpetually seral, presumably because of flooding and channel dynamics.

Freshets build stream banks and bring influxes of sediment, nutrients, and woody debris important to the ecosystem function of these sites. A flood cycle occurs every 20–30 years in a related riparian habitat type in Washington and Oregon (Crawford and Kagan 1998). Historically, beaver would have had considerable influence on these stands through herbivory; removing woody material; spreading willow cuttings that established; and controlling water levels as they dammed side channels.

Wildfires may have burned these stands in extremely dry years, leading to succession and replacement in the case of water birch, or to regrowth with shifts in species dominance in the case of shrub species. Water birch and mountain alder are thin-barked and susceptible to fire, but have the ability to produce abundant seed and resprout from basal buds (Haeussler et al. 1990; Hansen et al. 1996). Fires occurred with a frequency of every 25–50 years on related riparian habitat types in Washington and Oregon (Crawford and Kagan 1998). Much of the riparian vegetation, including *Betula occidentalis* and understorey shrubs, were killed by wildfire in one study (Royer and Minshall 1997). On the other hand, red-osier dogwood, roses, willows, and mountain alder can recover well and even increase their dominance after fire (Smith and James 1978; Haeussler et al. 1990; Bradley et al. 1992).

Ungulates may browse on willows, red-osier dogwood, and roses (Brown and Doucet 1991; Haeussler et al. 1990) in deep snow winters. However, water birch and mountain alder are not likely to be greatly affected, as they are not preferred browse (Haeussler et al. 1990; Hansen et al. 1996).

Fragility

Moderately fragile. Vulnerable to streamflow changes. Fragile soil base with sandy, silty, or organic textures, and with exposure to erosive events in floodplain positions. Less so on coarse soils with high coarse fragment content. Resilient for deep-rooted shrubs on these productive sites, but susceptible to understorey impacts and species invasions.

Conservation and Management

Status

The water birch/red-osier dogwood plant community is on the provincial *Red List* in British Columbia. It is ranked S1 in British Columbia. Its global status is unknown.

Trends

Declining. Much of the original extent of this community has been converted to agricultural use and channelled for water management. In 1995, an estimated 777 ha (13%) are extant, out of a historic total of 6025 ha. Further losses, as yet unmeasured, have occurred since these estimates (Dyer and Lea 2001; T. Lea, pers. comm.). Recent mapping (Dyer and Lea 2001) suggests that 20–50 occurrences remain, an increase from the previous estimate (CDC, unpubl. data), which was based on less information.

Threats

Most (87%) of this habitat in the Okanagan Valley has been lost to human development (Dyer and Lea 2001). What remains is mostly on private land. Threats and impacts include stream diversions such as channelization, privatization and subsequent conversion to cultivated fields and pasture, urban development, intensive grazing impacts, invasive species, and probably climate change.

Cattle tend to congregate in riparian areas, and can quickly eliminate the more palatable species such as rose and cow parsnip (*Heracleum* spp.). Continued use shifts the plant community composition to sod-forming grasses such as Kentucky bluegrass (*Poa pratensis*) and may promote the spread of invasive species. Loss of the deeper rooted grasses and replacement by these sodgrasses leads to instability in the stream banks, with consequential erosion and sedimentation and collapse. Cattle also impact the community by browsing shrubs such as willow and red-osier dogwood later in summer when grasses and forbs senesce (Roath and Krueger 1982). These shrubs are highly preferred by livestock and browsing ungulates (McLean 1979; Hansen et al. 1996).

Stream diversion, including channelization, threatens the integrity of obligate riparian species, such as water birch (Smith et al. 1991). Impacts are felt via moisture stress, especially during low flows experienced in years of reduced runoff (op. cit.). More subtle is the loss of bank building, influxes of woody debris, and the nutrients supplied with the annual surface deposition of sediments.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those occurring within protected areas and parks.

There are no current occurrences within protected areas, but there are opportunities to recover this community at Vaseaux Lake (Canadian Wildlife Service Vaseaux Lake Migratory Bird Sanctuary) and the north end of Osoyoos Lake (South Okanagan Wildlife Management Area) (Dyer and Lea 2001) and possibly in the Southern Grasslands and White Basin parks, and a range reference area exclosure at Fairview (R. Tucker, pers. comm.).

The *Forest and Range Practices Act* provisions for riparian areas, such as riparian management guidelines, may provide some protection for this community. Range use plans may be used to manage livestock grazing to ensure the protection of these communities. These plans may specify the Desired Plant Community and objectives for maintaining riparian communities in properly functioning condition. Because this community is a deciduous riparian community that does not contain commercial timber it is unlikely that old growth management areas would provide protection.

In Idaho, six riparian reference areas have been established for this community. Four of these are protected as follows: Tex Creek Wildlife Refuge/Management Area—about 60 ha out of 11 635 ha; Portneuf Wildlife Refuge/Management Area—8 ha out of 1256 ha; South Fork of the Snake River-Irwin to Heise TNC Preserve—an undetermined area out of 837 ha; and Allison Creek Island in the Salmon River—10 ha, not formally protected but situated on an island (Jankovsky-Jones et al. 1999).

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

This community has been recommended as the highest priority for conservation in the south Okanagan–Similkameen areas (Dyer and Lea 2001).

- ❖ Preserve and restore natural flood cycles that have historically maintained this community. This may involve restoring streams to their formal channels through the modification of current diversions, and restoring beaver to their natural hydrological role.
- ❖ Maximize connectivity of riparian areas. Where an occurrence of this community falls outside required riparian management areas, expand riparian management areas to include the occurrence of this community.
- ❖ Maintain or recover at least 20 occurrences in good condition across the range of the plant community.
- ❖ Maintain or restore occurrences to as close to natural condition as possible and practical.

Wildlife habitat area

Goal

Maintain or recover known occurrences.

Feature

Establish WHAs at occurrences that have been confirmed by a registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologists. Priority for WHAs should be on any climax condition occurrences. As a lower priority, WHAs may be established within earlier seral stages where the key species of the community are present in small patches, to recover community to climax condition.

Size

The size of the WHA should be based on the extent of the community occurrence. WHAs will generally be between 5 and 20 ha but may be larger, where the community has a patchy or linear distribution or where the community occurs in riparian complexes with other at-risk communities.

Design

The WHA should include the entire community occurrence plus 100 m around the perimeter of the occurrence. Wherever possible use geographic boundaries and features such as old stream bed channels. Minimize edge, unless occurrences are narrow, such as strips along stream channels. Include and protect stream banks, which, if disturbed, will disrupt sedimentation balances. Minimize inclusion of invasive species.

General wildlife measures

Goals

1. Maintain or restore plant community to a natural state (i.e., same species composition, physical structure, and ecological processes as natural examples of the plant community).
2. Set the following species as the Desired Plant Community: shrub cover >70%, composed of water birch (>15% cover), mountain alder (>5%), willows (as above, >7% cover), red-osier dogwood (>15% cover), poison ivy (>5% cover), roses (wood rose or Nootka rose, >5% cover), and sparse presence of star-flowered false Solomon's seal.
3. Manage to maintain and increase the species named above as the Desired Plant Community.
4. Maintain or restore natural hydrological regime. Accommodate changing stream bed conditions, cycles of sediment, nutrient and litter accumulation by channel maintenance/restoration, and control of disturbance.
5. Allow for natural flood cycles, sediment, and nutrient deposition and annual accumulations of plant litter.
6. Prevent physical disturbance, especially of the soil.

7. Minimize the introduction and spread of invasive species.
8. Maintain or restore to properly functioning condition.

Measures

Access

- Do not develop permanent or temporary roads.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to meet the general wildlife measure goals described above. Fencing could be required by the statutory decision maker to meet goals, to recover community, or for restoration treatments.
- Do not place livestock attractants within WHA.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation, soils, and hydrology when operating adjacent to a WHA, particularly during road development and maintenance.

Apply restoration treatments to recover natural hydrological characteristics and to reduce/eliminate invasive species and re-establish native species.

This community is not a fire-maintained ecosystem, but it should be permitted to experience longer-term renewal though wildfire and extreme flood events. Any occurring older trees and snags could be retained on site, as they have an important role for wildlife of the riparian zone and adjacent uplands.

Restrict recreational use (i.e., dirt bikes, mountain bikes, and other off-road vehicles).

Avoid linear or extensive soil disturbances, which can lead to sedimentation and ingress by weeds. Weed control will require special treatments, such as mechanical treatment, because of the sensitivity and restrictions associated with the riparian zone. Access concerns are centred on any concentrating effect they may have on livestock or wildlife distribution, and on access corridors serving for the spread of invasive species (e.g., Canada thistle).

Private land stewardship will be an important component of the conservation of this community as many sites occur on private land.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Monitoring of the herbaceous understorey composition with cattle exclusion and successional studies; and for any recovery trends in water birch communities without rose, red-osier dogwood, and other species.
3. Historical inference of past stream and riparian zone dynamics, and of the specific influence of beaver.

Cross References

"Great Basin" Gopher Snake, "Interior" Western Screech-Owl, Lewis's Woodpecker, Racer, Western Rattlesnake, Yellow-breasted Chat

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Alkali Saltgrass Herbaceous Vegetation

Distichlis spicata var. *stricta* herbaceous vegetation

Original prepared by T. Lea

Plant Community Information

Description

This saline, graminoid wetland meadow community is dominated by alkali saltgrass (*Distichlis spicata* var. *stricta*). This community is sometimes associated with the salt-tolerant grass, Nuttall's alkaligrass (*Puccinellia nuttalliana*). These meadows occur in seasonally flooded areas often associated with saline/alkaline potholes and lakes. Brief flooding in the early season is followed by pronounced surface drying leaving a distinct salt crust (MacKenzie and Shaw, in press). Vegetation is frequently stratified into subcommunities based on gradational changes in moisture and salinity (D. Gayton, pers. comm.) (Utzig et al. 1986).

Historically this community occurred with slender wheatgrass (*Elymus trachycaulus*) in the climax condition. Most of these communities are disturbed and are often dominated by bands of foxtail barley (*Hordeum jubatum*), which increases with grazing.

This community occurs at lower elevations, on all aspects, from mid to lower slopes, on gently sloping areas. Soils consist of fine-textured glaciolacustrine materials, which are typically wet in the early spring and dry out in the summer, particularly at the soil surface. The soils are alkaline or saline and may be Solonetzic.

Distribution

Global

Due to differences in plant community classification between British Columbia and surrounding jurisdictions, the extent of this community is not known.

British Columbia

This community occupies low elevations only at the southern end of the Rocky Mountain Trench.

Forest region and district

Southern Interior: 100 Mile House, Cascades, Central Cariboo, Chilcotin, Kamloops, Okanagan Shuswap, Quesnel, Rocky Mountain

Ecoprovince and ecosection

CEI: CAB, CHP, FRB

SIM: EKT

SOI: GUU, NIB, NOB, PAR, SOB, THB

Biogeoclimatic units

BG: xw2

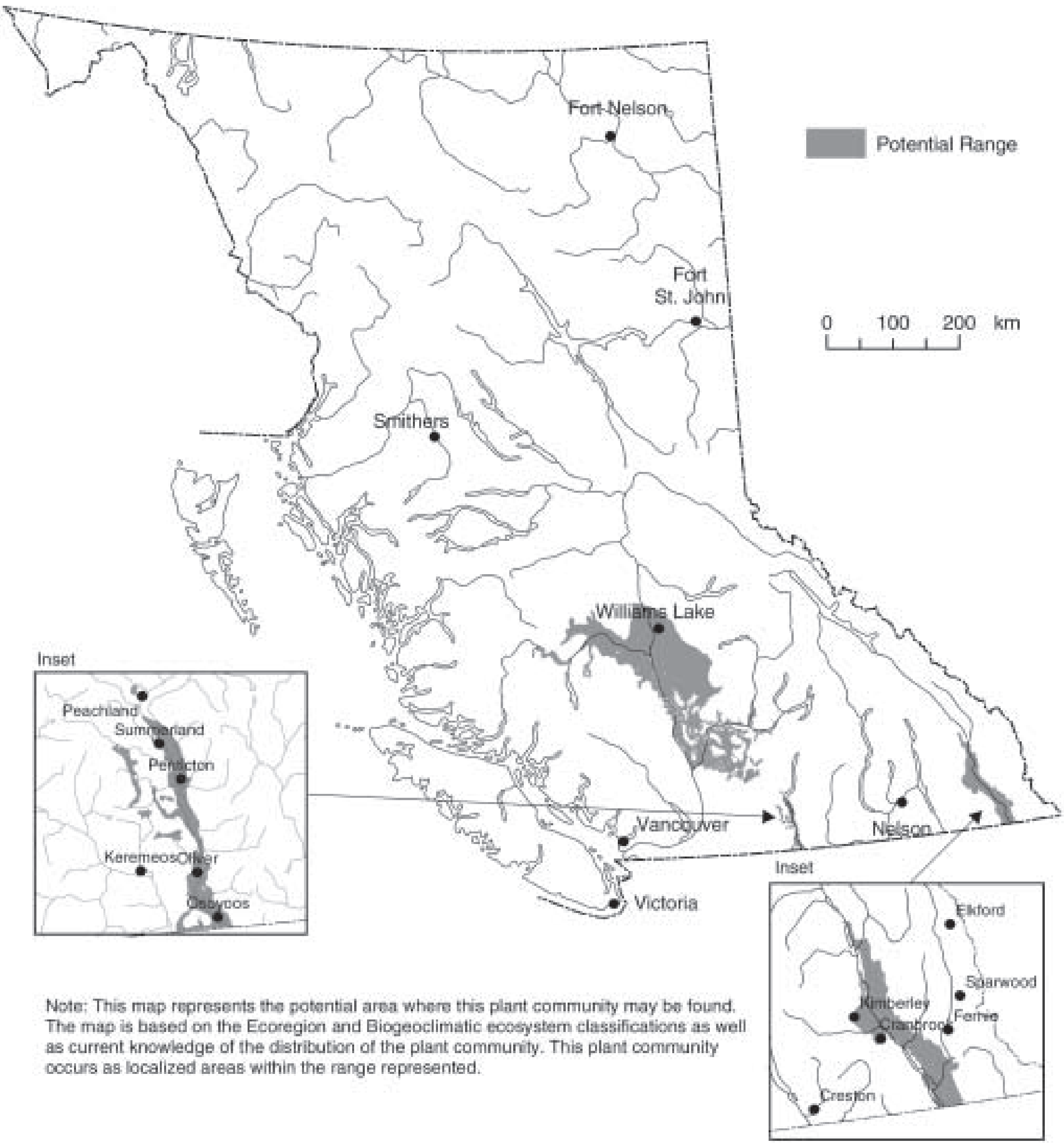
IDF: dk1, dk3, dk4, dm2/00, xm

PP: dh2/00, xh2

Broad ecosystem unit

ME

Alkali Saltgrass Herbaceous Vegetation
(Distichlis spicata var. stricta herbaceous vegetation)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

Plant Community Characteristics

Structural stage

2: herb

Natural disturbances regime

Frequent stand-maintaining fires (NDT4) (MOF and MELP 1995). Although this plant community occurs within NDT4, the main natural disturbance to this community is flooding.

Fragility

Very high. Very slow to recover from disturbance. Typically occurs on fine-textured lacustrine materials, which have high water tables in spring and droughty conditions in the summer. These are very susceptible to trampling by livestock, and extremely susceptible to overuse by all-terrain vehicles that have a very high impact on these communities. There is a high potential for water and wind erosion after vegetative cover is removed.

Conservation and Management

Status

The alkali saltgrass herbaceous vegetation plant community is on the provincial *Red List* in British Columbia. It is ranked S1 in British Columbia. Its global status is unknown.

Trends

There are <20 known occurrences. This community has a restricted range and where it occurs, it is generally in early to mid-seral stages. It is not known if any sites are in a late seral or climax condition. It is unknown if any of this plant community occurs in natural condition. Much of the area that originally supported this community has been disturbed by intensive livestock grazing and damaged by all-terrain vehicle use that has removed the vegetative cover and created deep ruts in the soils. This community is declining rapidly, with most examples having been grazed or disturbed by human activities (T. Braumandl, pers. comm.).

Threats

The major threats to this community are livestock grazing, which removes the natural vegetation, and all-terrain vehicles, which remove almost all vegetative cover. The biggest threat is soil compaction and trampling that occurs when soils are wet (D. Fraser, pers. comm.). Areas that have this community in its natural state are not known. Climate change may also be a threat.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those within protected areas and parks. It is believed that no sites are present in protected areas (T. Braumandl, pers. comm.).

The riparian and the range management guidelines enabled under the *Forest and Range Practices Act* provide some protection for these communities. Range use planning may address this community through implementation of similar recommendations as outlined below in “General wildlife measures.”

Identified Wildlife Recommendations

Sustainable resource management and planning recommendations

At present most of the known occurrences of this plant community are in an early seral stage and few if any are in a natural condition. It is recommended to:

- ❖ maintain at least 20 occurrences in good condition across the range of the plant community;
- ❖ maintain or restore occurrences to as close to natural condition as possible and practical; and
- ❖ manage livestock grazing to enable community to develop to a later seral stage.

Wildlife habitat area

Goal

Maintain and recover known occurrences.

Feature

Establish WHAs at occurrences that have been confirmed by a qualified registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologists.

Size

The size of the WHA should be based on the extent of the plant community occurrence. Typically occurrences of this plant community are <100 ha.

Design

The WHA should include the entire community occurrence and 100 m surrounding the occurrence to maintain the hydrologic regime and protect the community occurrence from edge effects and the introduction and spread of invasive species.

General wildlife measures

Goals

1. Maintain or restore plant community to a natural state (i.e., same physical structure, and ecological processes as natural examples of the plant community) and natural plant composition of this plant community (see “Description”).
2. Minimize or avoid access.
3. Prevent physical disturbance, especially of the soil.
4. Maintain or restore to a late seral stage.
5. Maintain hydrological regime.
6. Minimize the introduction and spread of invasive species.
7. Minimize forest encroachment.

Measures

Access

- Do not develop roads or trails.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to meet the general wildlife measure objectives described above. Fencing could be required by the statutory decision maker to meet general wildlife measure objectives, to recover community, or for restoration treatments.
- Do not place livestock attractants within WHA.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation, soils, and hydrology when operating adjacent to a WHA, particularly during road development and maintenance.

Restrict recreational use (i.e., dirt bikes, mountain bikes, and other off-road vehicles).

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Understanding of restoration techniques for alkaline/saline communities.
3. Understanding of hydrologic interactions with this community and the surrounding landscape and requirements to maintain the community and physical attributes of the sites.

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Acronyms

asl	above sea level
ATV	all terrain vehicle
BEC	biogeoclimatic ecosystem classification
BEU	broad ecosystem unit
CCLUP	Cariboo-Chilcotin Land Use Plan
CDC	Conservation Data Centre
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWD	coarse woody debris
dbh	diameter at breast height
FPC	Forest Practices Code
FRPA	*Forest and Range Practices Act*
GBMA	Grizzly Bear Management Area
GBPU	Grizzly Bear Population Unit
GWM	general wildlife measure
HLP	higher level plan
IWMS	Identified Wildlife Management Strategy
LTAC	Long-term Activity Centre
LWD	large woody debris
MOF	Ministry of Forests
MSRM	Ministry of Sustainable Resource Management
MWLAP	Ministry of Water, Land and Air Protection
NDT	natural disturbance type
OGMA	old growth management area
PFA	post-fledging area
RBC	results based code
RISC	Resource Information Standards Committee
RMA	riparian management area
RMZ	resource management zone
SD	standard deviation
SDM	statutory decision maker
s.e.	standard error
slv	snout-to-vent length
sp.	species (singular)
spp.	species (plural)
ssp.	subspecies
TAC	IWMS Technical Advisory Committee
TEM	Terrestrial ecosystem mapping
UWR	ungulate winter range
WAP	watershed assessment procedure
WHA	wildlife habitat area
WTP	wildlife tree patch

Glossary

For more definitions, refer to Glossary of Forest Terms web page (http://www.for.gov.bc.ca/hfd/library/documents/glossary/index.htm).

account: Specific information on taxonomy, distribution, life history, status, and management recommendations for Identified Wildlife.

age class: Any interval into which the age ranges of trees, forests, stands, or forest types is divided for classification and use; forest inventories commonly group trees into 20-year age classes.

allospecies: A group within one species composed by differences caused by territorial spread. They are becoming a species on there own.

Biogeoclimatic Ecosystem Classification: A hierarchical ecosystem classification system which has three levels of integration—regional, local, and chronological—and which combines climatic, vegetation, and site factors.

biogeoclimatic units: Units of a hierarchical ecosystem classification system having three levels of integration—regional, local, and chronological—and combining climatic, vegetation, and site factors.

biological diversity: The diversity of plants, animals, and other living organisms in all their forms and levels of organization, including the diversity of genes, species, ecosystems, and evolutionary and functional processes that link them.

Blue List: A list, prepared by the Ministry of Sustainable Resource Management, Conservation Data Centre, of elements considered to be vulnerable in British Columbia. Vulnerable elements are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed elements are at a lower level of risk than red-listed elements.

broad ecosystem unit: A permanent area of the landscape, meaningful to animal use, that supports a distinct kind of dominant vegetative cover, or distinct non-vegetated cover. These units are defined as including potential (climax) vegetation and any associated successional stages (for forests and grasslands).

coarse woody debris: Decaying wood on the ground that provides special microclimates and breeding habitat for a wide variety of organisms.

COSEWIC: An organization comprised of representatives from each provincial and territorial government wildlife agency which determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada.

costal grooves: A series of vertical grooves on the sides of salamanders, between the fore- and hind limb.

deactivate: Road deactivation is an engineering issue that involves application of techniques to stabilize the road prism, restore or maintain the natural drainage patterns, and minimize sediment transport to protect neighbouring resources at risk from potential landslide and sedimentation events.

desired plant community: A plant community that produces the kind, proportion, and amount of vegetation necessary for meeting or exceeding the stated objectives for a site according to a range use plan. The desired plant community must be consistent with the capability of the site to produce the vegetation through management, land treatment, or a combination of the two. The desired plant community takes into account multiple values, such as economics, biodiversity, water quality, wildlife/fisheries, forage, and recreation.

diameter at breast height: A measurement taken at approximately breast height (~1.5 m) and used as the standard for describing the diameter of a tree.

ecoprovince: An area with consistent climate or oceanography, relief, and plate tectonics.

ecosection: An area with minor physiographic and macroclimatic or oceanographic variation.

element: A species or a plant community. The term "species" includes all entities at the taxonomic level of species, such as subspecies, plant varieties, and interspecific hybrids.

Endangered: A COSEWIC designation indicating a species facing imminent extirpation or extinction.

epikarst: The uppermost layer of a karstified rock in which a large proportion of the fissures have been enlarged by solutional erosion.

extinct: A species that no longer exists.

follicle: A dry fruit derived from a single carpel, splitting open along the ventral suture at maturity.

fragility: Ability of the plant community to recover from disturbances.

gravid: When females are carrying fertilized eggs.

general wildlife measure: A management practice established for an area, by order, by the Minister of Water, Land and Air Protection, for (a) a category of species at risk, (b) a category of regionally important wildlife, or (c) a category of specified ungulate species.

hyporheic: An area of gravel and other sediments under or next to the streambed with water flowing through.

Identified Wildlife: A subset of species at risk and regionally important wildlife established by the Minister of Water, Land and Air Protection.

Identified Wildlife Management Strategy: A strategy enabled under the *Forest and Range Practices Act* to address the management of Identified Wildlife. The Strategy is comprised of two companion documents: *Accounts and Measures for Managing Identified Wildlife* and *Procedures Framework for Managing Identified Wildlife*.

Indeterminate: A COSEWIC designation for species that have been evaluated, but not enough information about them is available to determine their status.

inflorescence: A cluster of flowers.

instar: An insect stage between molts (growth).

invasive species: Species that are non-native or alien to the ecosystem under consideration, and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

karst: Terrain, generally underlain by limestone or dolomite (carbonate rocks), in which the topography is formed chiefly by the dissolving of rock, and which may be characterized by sinkholes, sinking streams, closed depressions, subterranean drainage, and caves.

lacustrine: Pertaining to a lake.

large woody debris: Woody debris in a stream, lake, or wetland setting, during at least part of the year, with a diameter of 10 cm or greater and a length of 2 m or greater.

livestock attractant: a substance or structure that draws livestock, including salt/minerals, supplements, water developments and cattle oilers.

Natural Disturbance Type: An area that is characterized by a natural disturbance regime.

NatureServe Explorer: An organization dedicated to providing reliable information on species and ecosystems for use in conservation and land use planning.

neotene: Amphibian larvae that mature to adult size without losing their external gills. They are sexually mature, obligate water-dwelling individuals.

Not at risk: A COSEWIC designation for species that have been evaluated and deemed not currently at risk.

occurrence: A location representing a habitat that sustains or otherwise contributes to the survival of a population (e.g., a south-facing slope that provides winter range for 10 elk would be considered a single occurrence, not 10).

old field: A field that has been left to grow.

old growth management area: A spatially identified area that is subject to old growth management objectives.

ovigerous: Bearing eggs.

oviparous: Reproduces by laying eggs.

ovoviviparous: Reproduces by eggs which remain in the female's body until ready to hatch. When the young emerge, they are born live.

parotid glands: Paired glands in the form of large bumps. In toads, these are located behind the eyes on the neck and secrete toxic substances used for defense.

perigynium: Special sac which encloses the achene in sedges; plural, peryginia.

periphyton: Attached algae.

petal: One of the segments of the corolla of a flower.

pinna: A leaflet or primary division of a pinnate leaf or frond: plural, pinnae.

pinnate: Compound leaf, with leaflets arranged on two sides of a common axis.

plant community: The plant community element, used by the Conservation Data Centre and this guidebook, is based on the plant association concept (V.J. Krajina and students): an abstract unit based on sample plots of climax vegetation that possess similar vegetation structure and native species composition, and occur repeatedly on similar habitats.

platform: With birds, the term is used to describe a nest type that is a flat structure (i.e., for Marbled Murrelets platforms are large limbs or deformities with epiphyte cover).

Predictive Ecosystem Mapping: A method of predicting ecosystem occurrence on the landscape given basic inventory information and expert knowledge.

properly functioning condition: Refers to: the ability of a stream, river, wetland or lake and its riparian area to (a) withstand normal peak flood events without experiencing accelerated soil loss, channel movement or bank movement, (b) filter runoff, and (c) store and safely release water, and when uplands associated with the riparian area exhibit (d) vegetation and biological processes, (e) infiltration rates and moisture storage, and (f) stability that is appropriate to soil, climate and landform.

raceme: An unbranched type of inflorescence presenting a symmetrical display of stalked flowers, with older flowers towards the base.

Red List: A list, prepared by the Ministry of Sustainable Resource Management, Conservation Data Centre, of elements being considered for or already designated extirpated, endangered, or threatened. Extirpated taxa no longer exist in the wild in British Columbia, but occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed.

regionally important wildlife: A category of species under FRPA (s.105) established by the Minister of Water, Land and Air Protection, by order, if satisfied that the species a) is important to a region of British Columbia, b) relies on habitat that requires special management that is not otherwise provided for in this regulation, and c) is vulnerable to impacts from forest practices or range practices.

rehabilitation (access measure): Rehabilitation of a road is typically done in accordance with a silviculture prescription or logging plan, and is normally carried out concurrently with, or following, deactivation to restore the affected area to a productive site for growing crop trees.

rhizome: A rootlike subterranean stem, commonly horizontal in position, which usually produces roots below and sends up shoots from the upper surface.

riparian habitat: The area adjacent to a watercourse, lake, swamp, or spring that is influenced by the availability of water and is generally critical for wildlife cover, fish food organisms, stream nutrients, and large organic debris, and for streambank stability.

sepal: One of the individual leaves or parts of the calyx of a flower.

seral stages: The stages of ecological succession of a plant community (e.g., from young stage to old stage). The characteristic sequence of biotic communities that successively occupy and replace each other by which some components of the physical environment become altered over time.

snag: Standing dead or partially dead tree.

snout-vent length: A standard measurement of body length. The measurement is from the tip of the snout to the vent and excludes the tail.

Special Concern: A COSEWIC designation indicating a species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.

Species at risk: A category of species under FRPA (s.105) established by the Minister of Water, Land and Air Protection, by order, if satisfied that the species in the category are endangered, threatened or vulnerable.

stalk: Stem or main axis of a plant.

stigma: Part of the pistil (female organ), which receives the pollen.

structural stage: Describes current vegetation focusing on the age class of the ecosystem in question. Stuctural stage will depend on subzone designation and vegetative species.

supercilium: A line of feathers above the eye.

Terrestrial Ecosystem Mapping: The stratification of a landscape into map units according to a combination of ecological features, primarily climate, physiography, surficial material, bedrock geology, soil, vegetation, and disturbance.

Threatened: A COSEWIC designation indicating a species likely to become endangered if limiting factors are not reversed.

tragus: A flap of skin at the base of the external ear.

watershed assessment procedure: An analytical procedure designed to help forest managers understand the type and extent of current water-related problems that may exist in a watershed, and to recognize the possible hydrological implications of proposed forestry and related development or restoration in that watershed.

wildlife habitat area: The Identified Wildlife Management Strategy provides foresters and ranchers with management practices for managing habitats for Identified Wildlife. The management practices must be followed within areas set aside for a particular species or plant communities. These areas are called "wildlife habitat areas" and are officially designated by the Minister of Water, Land and Air Protection.

wildlife habitat feature: A localized feature established, by order, by the Minister of Water, Land and Air Protection. Includes features such as fisheries sensitive features, marine sensitive features, significant mineral licks or wallows, and Bald Eagle, Osprey, and Great Blue Heron nests.

wildlife tree: A standing live or dead tree with special characteristics that provide valuable habitat for the conservation or enhancement of wildlife. Characteristics include large diameter and height for the site, current use by wildlife, declining or dead condition, value as a species, valuable location, and relative scarcity.

wildlife tree retention area: An area specifically identified for the retention and recruitment of suitable wildlife trees. It can contain a single wildlife tree or many.

Yellow List: List of vertebrates that are considered "not at risk" within the province.

Appendix 1. Technical Advisory Committee

Technical Advisory Committee (TAC)
09/99 – 11/02

Non-government representatives

BC Cattlemen's Association
David Borth

BC Endangered Species Coalition/ Federation of BC Naturalists
Elaine Golds

BC Environmental Network
Paula Rodriquez de la Vega (09/99 – 02/02)
Colin Campbell (since 03/02)

BC Wildlife Federation
Carol Hartwig (to 06/02)

BC Mining Association
Ken Sumanik (09/99 – 06/01)

Canadian Association of Petroleum Producers
Craig Popoff

Coast Lumber Manufacturing Association
Wayne Wall

Council of Forest Industries
Gilbert Proulx
Kari Stuart-Smith (since 04/02)

Federation of BC Woodlot Associations
Bill Hadden

University of British Columbia
Geoff Scudder

Government representatives

Ministry of Forests, Range Branch
Doug Fraser

Ministry of Forests, Forest Practices Branch
Brian Nyberg
Wayne Erickson (since 06/01)

Ministry of Water, Land and Air Protection, Biodiversity Branch
Susanne Rautio (09/99 – 09/00)
Stewart Guy (since 09/00)
Kathy Paige
Eric Lofroth (09/99 – 09/00)

Ministry of Sustainable Resource Management, CDC
Andrew Harcombe

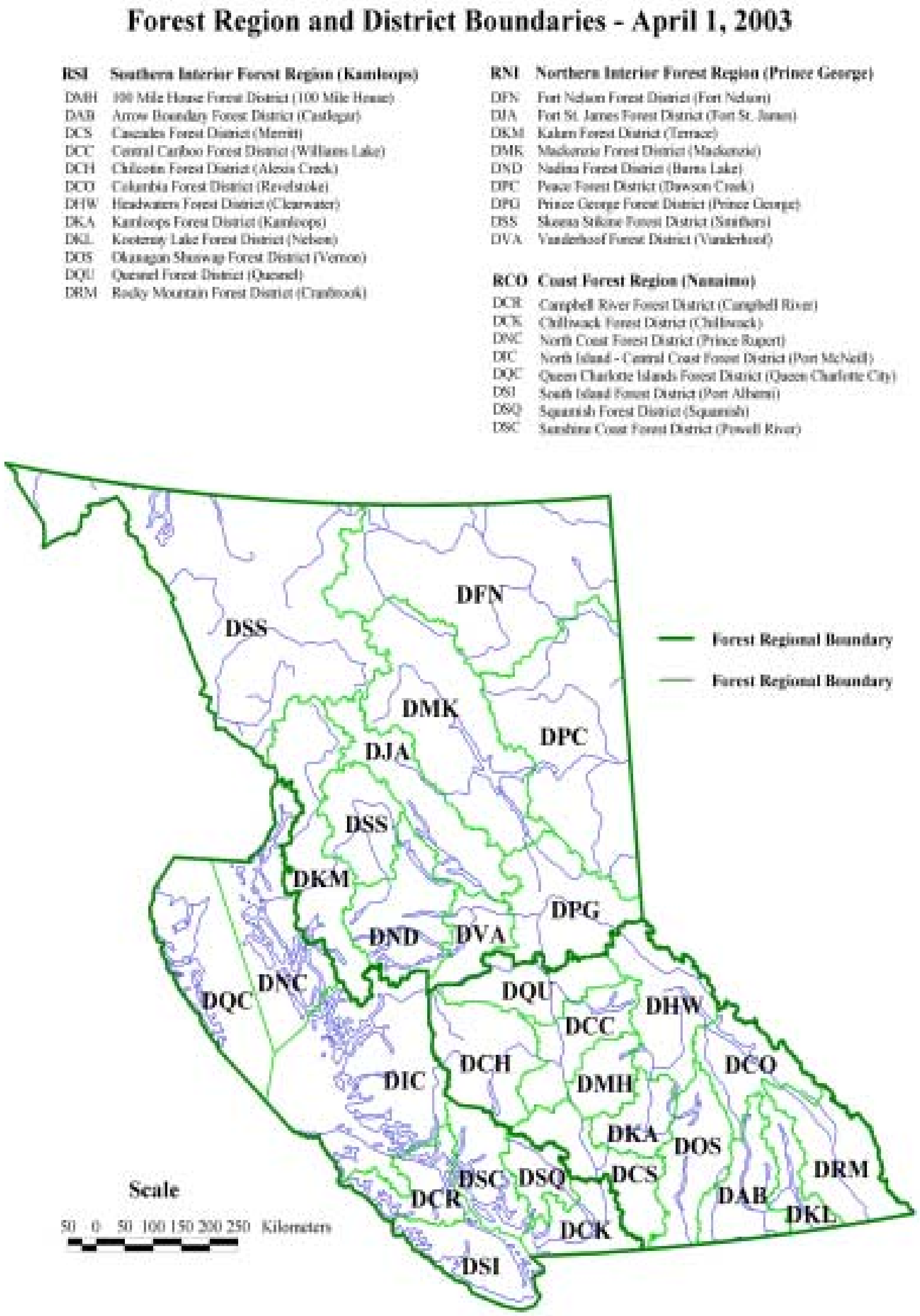
Ministry of Fisheries, Research
Gordon Haas (09/99 – 09/00)

Appendix 2. Summary of Volume 1 element changes

Element	IWMS priority (2003)	Included in IWMS (V. 2003)
American Bittern	Lower priority	No
American White Pelican	Highest priority	Yes
Ancient Murrelet	Intermediate priority	Yes
Bighorn Sheep	Intermediate priority	Yes
Bobolink	Lower priority	No
Bull Trout	Highest priority	Yes
Cassin's Auklet	Intermediate priority	Yes
Coastal Tailed Frog	Intermediate priority	Yes
Douglas-fir/Alaska Oniongrass	Intermediate priority	Yes
Ferruginous Hawk	Research required	No
Fisher	Intermediate priority	Yes
Grasshopper Sparrow	Intermediate priority	Yes
"Great Basin" Gopher Snake	Intermediate priority	Yes
Grizzly Bear	Intermediate priority	Yes
Keen's Long-eared Myotis	Highest priority	Yes
Lewis's Woodpecker	Intermediate priority	Yes
Long-billed Curlew	Intermediate priority	Yes
Marbled Murrelet	Highest priority	Yes
Mountain Beaver	Intermediate priority; use wildlife habitat feature designation	No
Night Snake	Lower priority	No
Pacific Water Shrew	Intermediate priority	Yes
Ponderosa Pine – Black Cottonwood – Nootka Rose – Poison Ivy	Lower priority	No
Ponderosa Pine – Black Cottonwood – Snowberry	Lower priority	No
Prairie Falcon	Intermediate priority	Yes
"Queen Charlotte" Goshawk	Highest priority	Yes
Racer	Intermediate priority	Yes
Rocky Mountain Tailed Frog	Intermediate priority	Yes
Sage Thrasher	Intermediate priority	Yes
"Sagebrush" Brewer's Sparrow	Intermediate priority	Yes
Sandhill Crane	Intermediate priority	Yes
Trumpeter Swan	Lower priority	No
Vancouver Island Marmot	Highest priority	Yes
Water Birch – Red-osier Dogwood	Highest priority	Yes
Western Grebe	Lower priority	No
White-headed Woodpecker	Intermediate priority	Yes
Yellow-breasted Chat	Intermediate priority	Yes

The following yellow-listed species were not assessed at this time: Mountain Goat, Northern Goshawk – *atricapillus* ssp., and Rubber Boa. These species were considered of lower priority and were not included so that highter priorities could be addressed. They may be considered once the regionally important wildlife list has been updated (last update was 1994) and a detailed evaluation and ranking, similar to that done for the red- and blue-listed elements (see Element Selection), is completed.

Appendix 3. Ministry of Forests administrative boundaries



Appendix 4. Ecoprovince and ecosection codes (Version 1.7)

Code	Ecoprovince/Ecosections	Code	Ecoprovince/Ecosections
COM	**Coast and Mountains Ecoprovince**	**SIM**	**Southern Interior Mountains Ecoprovince**
CBR	Central Boundary Ranges	BBT	Big Bend Trench
CPR	Central Pacific Ranges	BOV	Bowron Valley
CRU	Cranberry Upland	CAM	Cariboo Mountains
DIE	Dixon Entrance	CCM	Central Columbia Mountains
EPR	Eastern Pacific Ranges	COC	Crown of the Continent
HEL	Hecate Lowland	CPK	Central Park Ranges
HES	Hecate Strait	EKT	East Kootenay Trench
KIM	Kimsquit Mountains	ELV	Elk Valley
KIR	Kitimat Ranges	EPM	Eastern Purcell Mountains
MEM	Meziadin Mountains	FLV	Flathead Valley
NAB	Nass Basin	FRR	Front Ranges
NAM	Nass Mountains	MCR	McGillivray Ranges
NBR	Northern Boundary Ranges	NKM	Northern Kootenay Mountains
NIM	Northern Island Mountains	NPK	Northern Park Ranges
NPR	Northern Pacific Ranges	QUH	Quesnel Highland
NWC	Northwestern Cascade Ranges	SCM	Southern Columbia Mountains
NWL	Nahwiti Lowland	SFH	Selkirk Foothills
OUF	Outer Fiordland	SHH	Shuswap Highland
QCL	Queen Charlotte Lowland	SPK	Southern Park Ranges
QCS	Queen Charlotte Sound	SPM	Southern Purcell Mountains
QCT	Queen Charlotte Strait	UCV	Upper Columbia Valley
SBR	Southern Boundary Ranges	UFT	Upper Fraser Trench
SKP	Skidegate Plateau	**SOI**	**Southern Interior Ecoprovince**
SPR	Southern Pacific Ranges	GUU	Guichon Upland
VIS	Vancouver Island Shelf	HOR	Hozameen Range
WIM	Windward Island Mountains	LPR	Leeward Pacific Ranges
WQC	Windward Queen Charlotte Mountains	NIB	Nicola Basin
GED	**Georgia Depression Ecoprovince**	NOB	Northern Okanagan Basin
FRL	Fraser Lowland	NOH	Northern Okanagan Highland
GEL	Georgia Lowland	NTU	Northern Thompson Upland
JDF	Juan de Fuca Strait	OKR	Okanagan Range
LIM	Leeward Island Mountains	PAR	Pavilion Ranges
NAL	Nanaimo Lowland	SCR	Southern Chilcotin Ranges
SGI	Southern Gulf Islands	SHB	Shuswap Basin
SOG	Strait of Georgia	SOB	Southern Okanagan Basin
SAL	**Southern Alaska Mountains Ecoprovince**	SOH	Southern Okanagan Highland
ALR	Alsek Ranges	STU	Southern Thompson Upland
ICR	Icefield Ranges	THB	Thompson Basin
		TRU	Tranquille Upland

Code	Ecoprovince/Ecosections	Code	Ecoprovince/Ecosections
CEI	**Central Interior Ecoprovince**	**BOP**	**Boreal Plains Ecoprovince**
BUB	Bulkley Basin	CLH	Clear Hills
BUR	Bulkley Ranges	HAP	Halfway Plateau
CAB	Cariboo Basin	KIP	Kiskatinaw Plateau
CAP	Cariboo Plateau	PEL	Peace Lowland
CCR	Central Chilcotin Ranges	**NBM**	**Northern Boreal Mountains Ecoprovince**
CHP	Chilcotin Plateau	CAR	Cassiar Ranges
FRB	Fraser River Basin	EMR	Eastern Muskwa Ranges
NAU	Nazko Upland	HYH	Hyland Highland
NEU	Nechako Upland	KEM	Kechika Mountains
QUL	Quesnel Lowland	KLR	Kluane Ranges
WCR	Western Chilcotin Ranges	LIP	Liard Plain
WCU	Western Chilcotin Upland	MUF	Muskwa Foothills
TAP	**Taiga Plains Ecoprovince**	NOM	Northern Omineca Mountains
ETP	Etsho Plateau	SBP	Southern Boreal Plateau
FNL	Fort Nelson Lowland	SIU	Simpson Upland
MAU	Maxhamish Upland	STH	Stikine Highland
MUP	Muskwa Plateau	STP	Stikine Plateau
PEP	Petitot Plain	TAB	Tatshenshini Basin
TLP	Trout Lake Plain	TAH	Tagish Highland
SBI	**Sub-Boreal Interior Ecoprovince**	TEB	Teslin Basin
BAU	Babine Upland	TEP	Teslin Plateau
ESM	Eastern Skeena Mountains	THH	Tahltan Highland
HAF	Hart Foothills	TUR	Tuya Range
MAP	Manson Plateau	WHU	Whitehorse Upland
MCP	McGregor Plateau	WMR	Western Muskwa Ranges
MIR	Misinchinka Ranges		
NEL	Nechako Lowland		
NHR	Northern Hart Ranges		
NSM	Northern Skeena Mountains		
PAT	Parsnip Trench		
PEF	Peace Foothills		
SHR	Southern Hart Ranges		
SOM	Southern Omineca Mountains		
SSM	Southern Skeena Mountains		

Appendix 5. Biogeoclimatic ecological classification unit codes

Code	Zone
AT	Alpine Tundra
BG	Bunchgrass
BWBS	Boreal White and Black Spruce
CDF	Coastal Douglas-fir
CWH	Coastal Western Hemlock
ESSF	Engelmann Spruce–Subalpine Fir
ICH	Interior Cedar-Hemlock
IDF	Interior Douglas-fir
MH	Mountain Hemlock
MS	Montane Spruce
PP	Ponderosa Pine
SBPS	Sub-Boreal Pine–Spruce
SBS	Sub-Boreal Spruce
SWB	Spruce–Willow–Birch

Subzones are designated by 2 letters. The first letter indicates the precipitation regime:

x	very dry
d	dry
m	moist
w	wet
v	very wet

The second letter indicates continentality on the coast (CWH and MH):

h	hypermaritime
m	maritime
s	submaritime

and temperature regime in the interior (all other zones):

h	hot
w	warm
m	mild
k	cool
c	cold
v	very cold

For example,

CWHwh	Coastal Western Hemlock wet hypermaritime subzone
IDFww	Interior Douglas-fir wet warm subzone
BGxh	Bunchgrass very dry hot subzone

Appendix 6. Broad ecosystem units of British Columbia

Adapted from *Standards for Broad Terrestrial Ecosystem Classification and Mapping for British Columbia: Classification and Correlation of the Broad Habitat Classes used in 1:250,000 Ecological Mapping* (RIC 1998). See http://srmwww.gov.bc.ca/risc/pubs/teecolo/bei/assets/bei.pdf for more detailed descriptions.

Code	Name[1]	Description	BEC units
AB	Antelope-brush Shrub/ Grassland	Typically an open to dense, dry shrubland, generally lacking trees, that is dominated by drought-tolerant shrubs, most prominently antelope-brush and perennial grasses. Found at lower elevations, between 250 and 700 m; limited to the southern portion of the Okanagan Valley, mainly south of Penticton, extending to the U.S. border.	*BGxh1 PPxh1 PPdh2*
AC	Trembling Aspen Copse	Typically a dense deciduous or broad-leaved forest with a shrub-dominated understorey which includes plant communities that succeed through shrub thickets to an edaphic climax of trembling aspen; found in association with shrub/grasslands or grasslands. Found at lower elevations, between 330 and 1150 m, throughout the major river valleys of the Fraser Plateau and the Thompson–Okanagan Plateau, as well as in the Okanagan Valley and portions of the East Kootenay Trench.	*BGxw1 BGxw2 IDFdk1 IDFdk3 IDFdk4 IDFxh1 IDFxh2 IDFxm PPdh2 PPxh1 SBPSmk SBPSxc*
AD	Sitka Alder – Devil's-club Shrub	Typically a Sitka alder shrub community with a lush fern understorey, which occurs on steep slopes within the northern portion of the Interior Cedar-Hemlock zone. Typically found at lower elevations, between 150 and 1000 m, on the leeward side of the Coast Mountains, in river valleys.	*ESSFwk1 ICHmc1 ICHvc ICHwc*
AG	Alpine Grassland	Typically a high elevation, northern, grassland habitat, characterized by lush bunchgrass growth, with forbs, sedges, and terrestrial lichens. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AH	Alpine Heath	Typically a high elevation dwarf shrubland habitat, characterized by cold resistant vegetation, consisting of mountain-heathers, forbs, graminoids, and lichens. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AM	Alpine Meadow	Typically a high elevation, herbaceous community, dominated by moisture-loving forbs and/or sedges, on wetter sites in alpine areas. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	

1 Broad ecosystem unit names contain the dominant and/or characteristic climax and seral species.

Code	Name[1]	Description	BEC units
AN	Alpine Sparsely Vegetated	Typically a high elevation, sparsely vegetated habitat, characterized by a mixture of rocky slopes and a sparse cover of grasses, lichens, and low shrubs. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AS	Alpine Shrubland	Typically a high elevation, shrubland habitat, characterized by a dense cover of deciduous shrubs with graminoids, forbs, and terrestrial lichens. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AT	Alpine Tundra	Typically a high elevation, open to dense herbaceous or dwarf shrubland habitat, characterized by cold-resistant vegetation consisting of low dwarf shrubs, graminoids, hardy forbs, and lichens. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AU	Alpine Unvegetated	Typically a high elevation habitat dominated by rock outcrops, talus, steep cliffs, and other areas with very sparse vegetation of grass, lichens, and low shrubs. This unit is only found in the alpine tundra (AT) zone of the mountain ranges in the province.	
AV	Avalanche Track	Typically a dense shrub- or herb-dominated ecosystem where periodic snow and rock slides have prevented coniferous forest establishment, and abundant moisture is available for much of the growing season. Avalanche tracks characteristically begin in the alpine or subalpine zones where there is abundant snow accumulation and steeply sloping valley walls. There are no definite elevational limits, upper or lower. Slope breaks and snow accumulation determine the downslope extent of each avalanche track.	*AT CWHds1 CWHds2 CWHmm2 CWHms2 CWHvm1 CWHvh2 CWHvm2 CWHwm CWHws2 CWHxm MHmm1 MHmm2 BWBSdk BWBSmw BWBSvk BWBSwk ESSFdc ESSFdk ESSFmc ESSFmk ESSFmm ESSFmv ESSFmw ESSFvc ESSFwc ESSFwk ESSFwm ESSFwv ESSFxc ESSFxv ICHmc ICHmk ICHmm ICHmw ICHvc ICHvk1 ICHwc ICHwk IDFww MHmm1 MHmm2 MHwh MSdk MSxv SBPSmc SBSdh SBSmc SBSmk SBSvk SBSwk SWBdk SWBmk*

Code	Name[1]	Description	BEC units
BA	Boreal White Spruce –Trembling Aspen	Typically a dense, broad-leaved, mixed, or coniferous mixed forest with shrub- and herb-dominated understories, which includes plant communities that succeed through trembling aspen seral forests to a white spruce climax. Found in the northeastern portion of the province, from the intersection of the Rocky Mountains and the Alberta border north to the Yukon and Northwest Territories. Found at lower elevations, between 300 and 1050 m, in the more northerly locations. In the southern portions, it occurs at higher elevations, between 750 and 1050 m.	*BWBSmw1 BWBSmw2*
BB	Black Spruce Bog	A bog wetland class that typically is a sparse to open, treed organic wetland, with a peat moss-dominated understorey, black spruce and sometimes, tamarack. Found at low to mid-elevations, between 300 and 1250 m. It is common throughout the Taiga and Boreal Plains, Northern Boreal Mountains, Sub-Boreal Interior, Nass Basin, Southern Rocky Mountain Trench, and Fraser Plateau.	*BWBSdk1 BWBSdk2 BWBSmw1 BWBSmw2 BWBSwk1 BWBSwk2 BWBSwk3 ICHmc2 ICHmm ICHvk2 ICHwk3 SBPSdc SBPSmc SBPSmk SBSdh SBSdk SBSdw2 SBSmk1 SBSdw3 SBSmc2 SBSmc3 SBSmw SBSvk SBSwk1 SWBmk*
BG	Sphagnum Bog	A bog wetland class that typically is an unforested wetland, dominated by sphagnum mosses and herbaceous plants, found on poorly drained organic sites. Found throughout the province in poorly drained, wet sites, typically areas that are level or depressional. This very localized habitat is found at elevations ranging from sea level on the north coast to higher elevations (< 1800 m) in the Northern Interior. It is found at much higher elevations in the Southern Interior, usually above 1200 m.	
BK	Subalpine Fir – Scrub Birch Krummholz	Typically a northern, high elevation, stunted tree, open habitat, characterized by islands of subalpine fir intermixed with a dense shrub cover of willows and scrub birch. This unit is found at elevations above the upper limit of the Spruce–Willow–Birch (SWB) zone, approximately 1500 m and below the Alpine Tundra (AT) zone. It occurs throughout the subalpine areas of the Northern Boreal Mountains; small patches are also present in the Northern Omineca and Central Canadian Rocky Mountains, as well as on the Muskwa Plateau.	*SWBdk SWBmk SWBun*
BL	Black Spruce – Lodgepole Pine	Typically an open coniferous forest with shrub, moss, or terrestrial lichen understories, on gently sloping dry or wet sites, usually with lodgepole pine communities that progress to a black spruce climax. Generally found in the northern half of the province, north of 53 N. Located throughout the region east of the Rocky Mountains to	*BWBSdk1 BSBSdk2 BWBSmw1 BWBSmw2 BWBSwk1 BWBSwk2*

Code	Name[1]	Description	BEC units
		the Alberta border and north to the Northwest Territories. It is also found at lower to mid-elevations of the major river valleys in the Skeena, Omineca, and Central Rocky Mountains, as well as in the Fraser Basin, Rocky Mountain Trench, and northern portions of the Fraser Plateau. Typically, the elevation ranges between 350 and 1200 m. The majority of sites are located in cool areas, either low-lying valley floors or on north-facing slopes.	*SBPSdc SBPSmc SBSdw2 SBSdw3 SBSmc2 SBSmc3 SBSmk1 SBSmk2 SBSwk1 SBSwk2 SBSwk3*
BP	Boreal White Spruce – Lodgepole Pine	Typically a dense, boreal coniferous forest which includes plant communities that succeed through lodgepole pine seral forests to a white spruce climax. Found at elevations ranging from 300 to 1200 m throughout the northeastern plains, north of the Rocky Mountain/Alberta border intersection to the Northwest Territories. It also occurs extensively along the walls of major valleys in the northern Boreal Mountains, including the Northern Rocky Mountains, Cassiar Ranges, St. Elias Mountains, and all of the adjacent plateaus.	*BWBSdk1 BWBSdk2 BWBSmw1 BWBSwk1 BWBSwk2 BWBSwk3*
BS	Bunchgrass Grassland	Typically a dense herbaceous habitat dominated by perennial grasses and forbs and generally lacking shrubs or trees. Found at elevations ranging from 300 to 1650 m depending on the amount of moisture present. This unit occurs extensively throughout the lower to mid-elevations of the Southern Interior and southern portion of the Fraser Plateau; including the Fraser River, Thompson and Okanagan basins, as well as the valleys around the Fraser River in the Pavilion Ranges, the Nicola River, and the Similkameen River. More isolated ecosystems are also found in the Granby and Kettle River valleys of the Southern Okanagan Highland and in portions of the East Kootenay Trench.	*BGxh1 BGxh2 BGxh3 BGxw1 BGxw2 ESSFxc IDFdk1 IDFdk3 IDFdk4 IDFdm1 IDFxh1 IDFxh2 IDFxm MSxk PPdh1 PPdh2 PPxh1 PPxh2 SBPSdc SBPSmk SBPSxc SBSdk*
CB	Cedars – Shore Pine Bog	A bog wetland class that typically is an open to dense forest, with moss- and shrub-dominated understories. Sites are found in poorly drained outer coastal areas; often containing a varying mixture of western hemlock, western redcedar, yellow-cedar, and shore pine. Found at lower elevations throughout the coast and mountains, as well as the Georgia Depression, ranging from sea level to 1100 m.	*CDFmm CWHdm CWHds1 CWHds2 CWHmm1 CWHmm2 CWHms1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHwh1 CWHwm CWHws1 CWHws2 CWHxm*
CD	Coastal Douglas-fir	Typically a dense coniferous forest with shrub-dominated understories, including seral plant communities composed of Douglas-fir, which progress directly to climax. Occurs from sea level to ~ 700 m in southwest B.C. including the Gulf Islands, and Vancouver Island, east of the Vancouver Island Ranges and south of Kelsey Bay. It is also found in a narrow strip along the Mainland Coast,	*CDFmm CWHdm CWHds1 CWHmm1 CWHxm CWHds2 CWHmm2*

Code	Name[1]	Description	BEC units
		south of Bella Coola and in the southern portion of the Fraser Valley as well as east and north of Chilliwack into the drainages of the upper Fraser River and the eastern Coast Mountains.	
CF	Cultivated Field	Typically a mixture of farmlands where human agricultural practices of plowing, fertilization, and non-native crop production have resulted in long-term soil and/or vegetation changes. Generally, cultivated fields are located on flat to gently rolling terrain. Soil types and local climatic factors influence the types of crops that can be grown. The majority of the lower elevation plateaus and floodplains in the province are used for agriculture.	
CG	Coastal Western Redcedar – Grand Fir	Typically a dense coniferous forest which includes plant communities that progress through long-lived Douglas-fir seral stages to a varied climax of western redcedar and grand fir. Restricted to low elevations (sea level to ~150 m) along southeastern Vancouver Island from Bowser to Victoria, the Gulf Islands south of Cortes Island, and a narrow strip along the Sunshine Coast.	*CDFmm*
CH	Coastal Western Hemlock – Western Redcedar	Typically a dense coniferous forest, with shrub-dominated understories, found along outer coastal plains. Occurs in a narrow fringe (sea level to 600 m) along the outer coast of southern Vancouver Island widening to cover the northern portion of Vancouver Island, the windward side of the Queen Charlotte Ranges, and the Coast Mountains up the Mainland Coast to the Alaskan border.	*CWHmm1 CWHmm2 CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHwh1 CWHwh2*
CL	Cliff	Non-alpine, steep unvegetated rock slope. Cliffs are typically located throughout the province, mainly concentrated in mountainous regions. Cliffs are most often associated with many of the alpine units as well as the talus and rocky outcrop units.	
CP	Coastal Douglas-fir –Shore Pine	Typically a dry coniferous forest, characterized by plant communities composed of a sparse shrub layer and a well-developed moss and lichen layer, which proceeds to a Douglas-fir climax. Typical elevation ranges from sea level to approximately 650 m. This unit is found along the Sunshine Coast and in the lower Fraser Valley, extending inland along the major river valleys to its eastern limit in the Coast Mountains.	*CWHds1 CWHds2 CWHms1 CWHms2*
CR	Black Cottonwood Riparian Habitat Class	Typically a dense conifer and deciduous or broad-leaved forest with shrub-dominated understories, which includes plant communities that progress through a varying mixture of shrubs and black cottonwood. Found throughout the province along major rivers where floodplains occur, ranging in elevation from sea level to approximately 600 m.	*CDFmm CWHdm CWHds1 CWHds2 CWHmm1 CWHvm1 CWHxm BGxh1 BGxh2 BGxw2 BGxh3 ICHmc1 ICHmc2 ICHvc ICHwc IDF PPdh1 PPxh2*

Code	Name[1]	Description	BEC units
CS	Coastal Western Hemlock –Subalpine Fir	Typically a northern coastal, cold habitat, characterized by dense coniferous forests of western hemlock, subalpine fir, and spruce with dense shrub, moss, and lichen layers. Occurs in the Coast, Skeena, and Hazelton mountains, the Nass Basin, and the Stikine Plateau; ranging between 100 and 1100 m in elevation.	*ICHmc1 ICHmc1a ICHmc2 ICHvc ICHwc*
CW	Coastal Western Hemlock –Douglas-fir	Typically a dense coniferous forest with fern- or shrub-dominated understories, which includes plant communities that progress through long-lived Douglas-fir seral stages to a western hemlock climax. Found in lower to mid-elevations, ranging from sea level to approximately 700 m, in the southwestern portion of the province.	*CWHdm CWHds1 CWHds2 CWHxm*
DA	Douglas-fir – Arbutus	Typically a dense coniferous forest with shrub-dominated understories, whose plant communities may pass through seral stages with arbutus as a major component after intense fire, to a Douglas-fir climax. Occurs on the eastern side of Vancouver Island south of Kelsey Bay, on the Southern Gulf Islands, and on some of the islands located in Johnstone Strait. It also occurs in the lower Fraser Valley on the south side of the Fraser River as far as Chilliwack and along the Sunshine Coast up to Desolation Sound. It ranges in elevation from sea level to approximately 700 m.	*CDFmm CWHdm CWHxm*
DF	Interior Douglas-fir Forest	Typically a dense coniferous forest with grass- or shrub-dominated understories, which includes plant communities that progress directly to a Douglas-fir climax. Occurs in the Southern Interior at low to moderate elevations in the Interior Douglas-fir biogeoclimatic zone. Elevational limits range between 700 and 1100 m.	*BGxh3 BGxw2 IDFdk1 IDFdk2 IDFdk3 IDFdk4 IDFdm1 IDFdm2 IDFmw1 IDFmw2 IDFxh2 IDFxm IDFxw IDFww SBPSmk SBSdk SBSdw1 SBSdw2 SBSmc1 SBSmh ICHmk1 ICHmk2 ICHmw3 ICHxw MSdk MSdm1 MSdm2 MSxk*
DL	Douglas-fir – Lodgepole Pine	Typically a dense coniferous forest with shrub- or pinegrass-dominated understories, which includes plant communities that progress through a mixture of lodgepole pine and Douglas-fir or trembling aspen to a Douglas-fir climax. Found at lower to middle elevations (between 400 and 1600 m) throughout the central and Southern Interior.	*ICHmk1 ICHmk2 ICHmw1 ICHmw2 ICHmw3 IDFdk1 IDFdk2 IDFdk3 IDFdk4 IDFww IDFdm1 IDFdm2 MSdc MSdm1 MSdm2 MSxk SBSdh SBSdw1 SBSdw2 SBSdw3 SBSmh SBSmm SBSmw SBPSmk SBPSxc*

Code	Name[1]	Description	BEC units
DP	Douglas-fir – Ponderosa Pine	Typically an open to dense coniferous forest with shrub- or bunchgrass-dominated understories, which includes plant communities that progress through a mixture of Douglas-fir and ponderosa pine to a Douglas-fir climax. Occurs at low elevations in the valleys of the Southern Interior, including the Okanagan and Nicola valleys, as well as the valleys of the North and South Thompson, Bonaparte, Fraser, Similkameen, Kettle, and Granby rivers. Typically found at elevations ranging between 450 and 1300 m.	*ICHdw ICHxw IDFmw1 IDFdk1 IDFdk2 IDFdm1 IDFdm2 IDFxh1 IDFxh2 IDFxw PPxh1 PPdh1 PPxh2*
EF	Engelmann Spruce – Subalpine Fir Dry Forested	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that may progress through seral lodgepole pine to a varied climax of Engelmann spruce and subalpine fir. In the southern and central Interior of the province, this unit represents the highest elevation forested area. It occurs throughout the Coast Mountains and eastward into the Rocky Mountains, ranging in elevation between 1275 and 2050 m. There is considerable range in upper and lower elevational limits due to climatic and topographic variability.	*ESSFdc1 ESSFdc2 ESSFdk ESSFdv ESSFmc ESSFmm1 ESSFmk ESSFmw ESSFmv1 ESSFmv2 ESSFmv3 ESSFmv4 ESSFwc1 ESSFwc2 ESSFwc3 ESSFwc4 ESSFwk1 ESSFwk2 ESSFwm ESSFvv ESSFwv ESSFxc ESSFxv MSdc*
ER	Engelmann Spruce Riparian	Typically a dense coniferous forest, with shrub- and forb-dominated understories, Engelmann spruce and sometimes black cottonwood; found on floodplains or small riparian areas. Occurs on floodplains and riparian areas throughout the central, southern, and sub-boreal Interiors, as well as in the Southern Interior Mountains and the eastern slopes of the Coast Mountains. Elevational limits range between 1200 and 2000 m in the south, and 900 and 1500 m in the north.	*ESSFdc1 ESSFdk ESSFdv ESSFmc ESSFmk ESSFmm1 ESSFmv1 ESSFmv2 ESSFmv3 ESSFmv4 ESSFmw ESSFvc ESSFwc1 ESSFwc2 ESSFwc3 ESSFwc4 ESSFwk1 ESSFwk2 ESSFwm ESSFwv ESSFxc ESSFxv*

Code	Name[1]	Description	BEC units
ES	Estuary	Typically an unforested tidal wetland dominated by persistent emergent herbaceous species, with open sporadic access to ocean areas and where the seawater is periodically diluted with fresh water derived from land drainage. Estuaries occur along coastal B.C. where perennial rivers flow into the ocean.	*CDFmm CWHdm CWHmm1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHwh1 CWHwm CWHws1 CWHxm1 CWHxm2*
EW	Subalpine Fir – Mountain Hemlock Wet Forested	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that progress directly to a mixed climax of subalpine fir, mountain hemlock, and sometimes amabilis fir. Generally found in the eastern Kitimat ranges, south/central Hazelton Mountains, southeast Boundary ranges, and northwest Skeena Mountains. The elevational limits range between approximately 900 and 1800 m. There is also a limited amount of this unit on the leeward side of the Pacific ranges as well as in the western Monashee Mountains, between 1275 and 1675 m.	*ESSFmk ESSFmw ESSFvc ESSFvv ESSFwv*
FB	Subalpine Fir – Scrub Birch Forested	Typically a northern, subalpine, open forested habitat, characterized by stands of subalpine fir and white spruce with a dense shrub understorey of willows and scrub birch. This unit is limited to elevations ranging between 1050 and 1500 m. It occurs in the subalpine areas of the Northern Boreal Mountains including the Northern Omineca, Cassiar, St. Elias, and Northern Rocky Mountains, as well as the Stikine, Teslin, and Southern Boreal plateaus.	*BWBSdk1 BWBSdk2 BWBSvk SWBdk SWBmk SWBvk*
FE	Sedge Fen	A fen wetland class is typically an unforested wetland, dominated by sedges, found on poorly drained organic sites. This very localized ecosystem unit generally occurs in small patches throughout all forested zones within the province. It is most commonly found on the interior plateaus and does not occur in the AT zone.	
FP	Engelmann Spruce – Subalpine Fir Parkland	Typically a high elevation mosaic of stunted-tree clumps and herb- or dwarf shrub-dominated openings, occurring above closed forest ecosystems and below the alpine communities. In the southern and central Interior of the province, this unit represents the transition between the Engelmann Spruce – Subalpine Fir (ESSF) and Alpine Tundra (AT) zones. It occurs throughout the Coast Mountains and eastward into the Rocky Mountains, usually present above the ESSF zone (approximate elevation 2050 m). Note that there is considerable range in the upper and lower elevational limits due to climatic variability and differing topography.	*ESSFdc ESSFdk ESSFdv ESSFmc ESSFmm1 ESSFmm2 ESSFmv1 ESSFmv2 ESSFmv3 ESSFwc1 ESSFwc2 ESSFwc3 ESSFvc ESSFwk1 ESSFwk2 ESSFwm ESSFxc ESSFxv*

Code	Name[1]	Description	BEC units
FR	Amabilis Fir – Western Hemlock	Typically a low elevation, dense coniferous forest with fern- or shrub-dominated understories, which includes plant communities that may contain western redcedar as a long-lived seral species, leading to a mixed western hemlock and amabilis fir climax. Commonly occurs at low to middle elevations, between 500 and 1100 m, occasionally down to sea level. This unit is found extensively throughout the major valleys of the windward and leeward portions of the Coast Mountains, Vancouver Island Ranges, and Queen Charlotte Ranges, as well as on the outer coast of southern Vancouver Island and the adjacent northern Gulf Islands.	*CWHmm1 CWHmm2 CWHms1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHws1 CWHws2 ICHmc1a*
FS	Fast Perennial Stream	Typically a freshwater riverine habitat contained within a channel that has continuously moving, fast flowing water, that is bounded by banks or upland habitat and has a high gradient. Distributed throughout the province with a larger proportion of fast flowing streams found at higher altitudes where there is a larger gradient.	
GB	Gravel Bar	Typically a level, unvegetated, or partially vegetated fluvial area along an active watercourse. Found extensively along streams and rivers throughout the province.	
GL	Glacier	Typically a field or body of snow or ice formed in higher elevations in mountainous terrain where snowfall exceeds melting: these areas of snow and ice will show evidence of past or present glacier movement. Glaciers are generally found above 1800 m in the higher elevation biogeoclimatic zones throughout the mountain ranges of the province.	*AT BWBSdk1 CWHds1 CWHwm CWHws2 ESSFmm1 ESSFmw ESSFxv MHmm2 SWBdk SWBmk SWBvk*
GO	Garry Oak	Typically a sparse to open mixed forest, with understories dominated by mosses and a dense mixture of spring wildflowers and grasses growing on shallow, rocky sites. This ecosystem is very limited in distribution, occurring at low elevations along southeast Vancouver Island and the Gulf Islands. Elevational limits range between sea level and approximately 150 m.	*CDFmm*
HB	Coastal Western Hemlock – Paper Birch	Typically a dense mixed forest composed of paper birch, Douglas-fir, western redcedar, and western hemlock with shrub-dominated understories. Occurs at low elevations in submaritime and subcontinental areas north of Knight Inlet, ranging in elevation from valley bottom to approximately 500 m.	*CWHds1 CWHds2*
HL	Coastal Western Hemlock – Lodgepole Pine	Typically an open to dense coniferous forest situated on dry sites with shrub-dominated understories, which includes plant communities that progress through lodgepole pine seral stages to a western hemlock climax. This very uncommon ecosystem type is limited to dry ridge-crests and rocky outcrops along the outer coast to the Alaskan border, including Vancouver Island, the Queen Charlotte Islands, and any of the small coastal islands. It can also be found throughout the coast, western Hazelton, and Skeena mountains, and the Nass Basin. It ranges in elevation between sea level and 1000 m.	*CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHws1 CWHws2 ICHwc*

Code	Name[1]	Description	BEC units
HP	Mountain Hemlock Parkland	Typically a high elevation, sparse to open mosaic of stunted tree clumps and herbaceous or mountain-heatherdominated openings, that proceeds after disturbance directly to a climax species mix dominated by mountain hemlock. Found at high elevations along the coast, this unit represents the transition between the Mountain Hemlock (MH) and Alpine Tundra (AT) zones. When present, it occurs above the MH zone on the eastern and western slopes of the Vancouver Island Ranges, Queen Charlotte Mountains, and Coast Mountains, as well as the western slopes of the Hazelton Mountains; elevation approximately 1600 m. Note there is considerable range in the upper and lower elevational limits due to climatic variability and differing topography.	*MHmm1 MHmm2 MHwh*
HS	Western Hemlock – Sitka Spruce	Typically a dense coniferous forest along outer coastal sites with shrub-dominated understories, which usually succeeds directly to a mixed climax of western hemlock and Sitka spruce. Occurs along the west and north coast of Vancouver Island and the Queen Charlotte Islands. It is also found throughout the windward portion of the Coast Mountains, extending from Knight Inlet northward into the Boundary Ranges. Typically this unit occurs at elevations ranging between sea level and approximately 600 m.	*CWHds2 CWHvh1 CWHvh2 CWHwh1 CWHwh2 CWHwm*
IG	Interior Western Redcedar	Typically a dense coniferous or mixed forest with extensive shrub- and herb-dominated understories, which includes plant communities that progress through seral Douglas-fir, trembling aspen, and paper birch to a climax of western redcedar and grand fir. ICHxw has a very limited distribution in B.C. It is only found in middle, lower, and toe slope positions, as well as along the valley floor in the southern extremities of the Selkirk and Purcell mountains. Elevational limits range from 450 to 1100 m.	*ICHxw*
IH	Interior Western Hemlock – Douglas-fir	Typically a dense coniferous forest with various shrub- and herb-dominated understories, which includes plant communities that proceed through Douglas-fir, western larch, western white pine, and/or paper birch seral stages to a mixed climax of western hemlock and western red-cedar. Found extensively at low to middle elevations throughout the Columbia Mountains and Highland. Typically ranges in elevation between approximately 400 and 1400 m.	*ICHdw ICHmm ICHmw1 ICHmw2 ICHmw3 ICHvk1 ICHvk2 ICHwk1 ICHwk2 ICHwk3 ICHwk4*
IM	Intertidal Marine	Typically a habitat that consists of ocean overlying the continental shelf and its associated high energy shoreline, with salinities in excess of 18 ppt and a substrate that is exposed and flooded by tides (includes associated splash zone). This unit occurs along the shores of all coastal islands and the mainland, including major inlets, fjords, bays, and open ocean.	*CDFmm CWHdm CWHmm1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHwh1 CWHwm CWHws1 CWHxm1 CWHxm2*

Code	Name[1]	Description	BEC units
IN	Intermittent Stream	Typically a freshwater riverine habitat contained within a channel that only periodically has moving water and is bounded by banks or upland habitat. Occurs throughout the province in areas where there is not enough water supply to support perennial flow.	
IS	Interior Western Hemlock – White Spruce	Typically a dense coniferous forest with shrub- and moss-dominated understories, which includes plant communities that may progress through long-lived seral sub-alpine fir, spruce, and lodgepole pine to a climax of western hemlock and western redcedar. Found extensively at low to middle elevations throughout the Columbia Mountains and highlands. Typical range of elevation is between approximately 400 and 1400 m. Small pockets are also present in the Southern Nass Basin and Skeena and Hazelton mountains.	*ICHdw ICHmc2 ICHmm ICHmk3 ICHmw1 ICHmw2 ICHmw3 ICHvk1 ICHvk2 ICHwk1 ICHwk2 ICHwk3 ICHwk4 ICHxw*
LL	Large Lake	Typically a fresh deepwater habitat that includes permanently flooded lakes, usually found in a topographical depression, lacking emergent vegetation except along shorelines, and usually greater than 60 ha.	
LP	Lodgepole Pine	Typically an open lodgepole pine forest with shrub, moss, or terrestrial lichen understories on level, nutrient-poor, coarse-textured soils. Found extensively between 500 and 1600 m, throughout the interior of the province. It occurs in the Southern Interior Mountains, throughout the Columbia range, in the sub-boreal, central, and Southern Interior, as well as throughout the Fraser Plateau, Fraser Basin, Skeena and Omineca mountains, Thompson-Okanagan Plateau, and the leeside of the Pacific Ranges. It is also common within portions of the Taiga and Boreal Plains and Northern Boreal Mountains, and along the North Coast.	*BWBSdk1 BWBSdk2 BWBSmw1 BWBSmw2 BWBSwk1 BWBSwk2 BWBSwk3 ICHmc1 ICHmc2 ICHwk1 IDFdk4 ESSFdc2 ESSFmv1 ESSFwc2 ESSFxc ESSFxv1 MSdk MSdm2 MSdm1 MSxv SBPSdc SBPSmc SBPSmk SBPSxc SBSdh SBSdk SBSdw1 SBSdw2 SBSdw3 SBSmc1 SBSmc2 SBSmc3 SBSmk1 SBSmk2 SBSmm SBSmw SBSvk SBSwk1 SBSwk2 SBSwk3*
LS	Small Lake	Typically a fresh deepwater habitat that includes permanently flooded lakes (and sometimes reservoirs), usually 8 to 60 ha in a topographic depression, with most of the water less than 7 m in depth. Small lakes occur throughout the province in small valleys and basins.	

Code	Name[1]	Description	BEC units
ME	Meadow	A meadow wetland class that typically is a lower elevation herbaceous community, dominated by moisture-loving species, on imperfectly to poorly drained mineral soil sites. Occurs, to a limited extent, at lower elevations throughout the southern portion of the province, including Vancouver Island, the Mainland Coast, and Okanagan and Kootenay regions. It is most commonly found within the Fraser Plateau area. Meadows do occur in most southern biogeoclimatic zones, with the exception of the AT zone.	
MF	Mountain Hemlock – Amabilis Fir	Typically a high elevation, dense coniferous forest with shrub-dominated understories, which proceeds after disturbance directly to a climax species mix of mountain hemlock, western hemlock, and amabilis fir. This unit occurs in high elevation areas along the coast, including the eastern and western slopes of the Vancouver Island Ranges, Queen Charlotte Mountains, and Coast Mountains, as well as the western slopes of the Hazelton Mountains. It is limited to elevations ranging between 800 and 1600 m. Note there is considerable range in the upper and lower elevation due to climatic variability and differing topography.	*MHmm1 MHmm2 MHwh*
MI	Mine	Typically an area where mining exploration is presently taking place or where mining has recently been completed. Mining activity occurs in all regions of the province, covering large or small areas, depending on the minerals that are desired and the terrain. Open pit mining is commonly used for mineral extraction. Open pit mines are holes in the ground, varying in size and shape, which are open to the sky and have been created to extract minerals or aggregates (including gravel pits). Mines can also be in the form of complex underground tunnels, with only a few tunnels that actually connect to the surface, often via a central mine shaft. Another common feature associated with mining activity are mine tailings or rubbly mine spoils. These are areas containing the waste rock or overburden that is discarded in the extraction of ore in a mining operation.	
MR	Marsh	A marsh wetland class that typically is permanently or seasonally inundated and that supports an extensive cover of emergent, non-woody vegetation rooting in mineral-rich substrate. Found in a limited extent throughout lower elevation sites in the province. Marshes generally occur below 800 m.	
MS	Montane Shrub/Grassland	Typically a varied mixture of shrubs, thickets, and herbaceous openings found in steep breaks along lower river valleys. This type of habitat occurs in a very limited extent, usually in small patches throughout many of the river valleys in the province. It typically ranges in elevation between 350 and 1200 m.	*BGxh3 BWBSmw1 BWBSdk1 BWBSdk2 IDFxh1 MSxv SBPSdc SBPSmc SBSdk SBSdw2 SBSmc2 SBSmc3*

Code	Name[1]	Description	BEC units
OA	Garry Oak – Arbutus	Typically a sparse to open mixed forest, with understories dominated by mosses and a dense mixture of spring wildflowers and grasses, growing on shallow, rocky sites. Restricted to rocky areas of the Coastal Douglas-fir (CDFmm) and Coastal Western Hemlock (CWHxm1) biogeoclimatic subzones of southern Vancouver Island and adjacent Gulf Islands, and a few sites in the southern portions of the Fraser Valley.	*CDFmm CWHxm1*
OV	Orchard/Vineyard	Typically an agricultural area used for growing hard and soft fruit crops, with some form of symmetrical arrangement of the trees, shrubs, or vines. Concentrated in very arid regions of the province including the river valleys of the south Fraser, Thompson, and Similkameen rivers; the Okanagan Valley; and southeastern Vancouver Island. Typically orchards and vineyards are associated with the Coastal Douglas-fir, Interior Douglas-fir, Ponderosa Pine, and Bunchgrass biogeoclimatic zones.	
OW	Shallow Open Water	A shallow open water wetland class that typically is comprised of permanent shallow open water and that lacks extensive emergent plant cover; water is usually less than 2 m in depth, with submerged and floating aquatic plants present. Generally found throughout the province at elevations below 1000 m.	
PB	Lodgepole/Shore Pine Bog	A bog wetland class characterized by a sparse cover of stunted shore pine and poorly drained coastal soils. Shrubs and sphagnum moss dominate the understorey. Typically found along eastern Vancouver Island south of Kelsey Bay, throughout the Lower Mainland and up the Mainland Coast, including the western slopes of the Coast Mountains, Hecate Lowland, Outer Fiordland, Georgia Lowland, and the southern Gulf Islands, as well as the islands of Queen Charlotte Strait and the Strait of Georgia. The elevational limits of this unit range between sea level and 700 m.	*CWHds1 CWHds2 CDFmm1 CWHms1 CWHms2 CWHxm*
PO	Lodgepole Pine Outcrop	Typically a sparse to open lodgepole pine forest, with understories dominated by moss, lichens, and grasses, growing on shallow, rocky sites. Limited to areas with shallow soils over bedrock, within the Pacific Ranges.	*CWHxm CWHdm MSxv SBPSxc*
PP	Ponderosa Pine	Typically a sparse to open coniferous forest with shrub- or perennial grass-dominated understories, which occurs along the grassland/forest borders, leading to a ponderosa pine and Douglas-fir climax. Occurs at low elevations in the major valleys of the Thompson/Okanagan Plateau, including the Thompson and Okanagan basins. It also occurs in the East Kootenay Trench and in the Fraser Valley from north of Lillooet to just south of Lytton. Generally found below 500 m in elevation.	*BGxh1 BGxh2 BGxw1 IDFxh1 PPdh1 PPdh2 PPxh1 PPxh2*

Code	Name[1]	Description	BEC units
PR	White Spruce – Balsam Poplar Riparian	Typically a dense, deciduous, mixed or coniferous forest, with thick shrub understories, found on or in association with fluvial sites; includes plant communities that succeed through deciduous forests to a white (or hybrid white) spruce climax. This unit occurs between 300 and 1200 m in the northern portions of the province, throughout the major river valleys of the Northern Boreal Mountains, Boreal and Taiga Plains, as well as in the Southern Omineca and Central Canadian Rocky mountains.	*BWBSdk1 BWBSdk2 BWBSmw1 BWBSmw2 BWBSwk1 BWBSwk2 SWBdk SWBmk SWBvk*
RB	Western Redcedar – Paper Birch	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that succeed through deciduous seral stages or through Douglas-fir, lodgepole pine, and western larch (sometimes) to a climax of western redcedar and hybrid spruce. Commonly found in valley bottoms and lower slopes between 800 and 1400 m. Distributed throughout the Shuswap, Quesnel, and Okanagan highlands, as well as the North Thompson Upland, Southern Fraser Plateau, Southern Rocky Mountain Trench, and the leeside of the Cascade Mountains.	*ICHdk ICHmk2 ICHmk3 ICHmw3 IDFdk2*
RD	Western Redcedar – Douglas-fir	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that succeed through Douglas-fir, lodgepole pine, and western larch (sometimes) to a climax of western redcedar. Found at low elevations (300–1200 m) in the Shuswap, Quesnel, and Okanagan Highlands and the southern Fraser Plateau. It also occurs in the southern Rocky Mountain Trench and the southern Monashee and Purcell mountains, as well as in the leeward Pacific range and the southern Chilcotin range.	*ICHdk ICHmk1 ICHmk3 ICHmm ICHmw2 ICHwk4 IDFmw1 IDFmw2 IDFww IDFxh2*
RE	Reservoir	Typically a fresh, dammed, deepwater habitat that is permanently flooded, with variable water levels. Found all over the province, mainly at lower elevations.	
RM	Reclaimed Mine	Typically a mined area or mine tailings that have plant communities composed of a mixture of agronomic grasses, forbs, and native plants. Mining activity has taken place in all regions of the province, covering large and small areas, depending on the minerals that were desired and the terrain . Reclaimed mines usually contain a mixture of native and introduced plant species. The density and composition of these communities is related to the age and location of the site, as well as the amount of disturbance that resulted from the mining activities. In some areas of the province, the disturbances caused by mining activities may have provided the ideal conditions for particular native plant species, which have flourished since the operation ceased. However, in other heavily disturbed areas, agronomic species may have been seeded to stabilize the soils and have subsequently dominated these previously mined sites.	

Code	Name[1]	Description	BEC units
RO	Rock	Typically a mixture of gentle to steep, non-alpine bedrock escarpments and outcroppings with little soil development and relatively low vegetative cover. Found anywhere exposed bedrock is located in non-alpine regions of the province. Occurs extensively in mountainous areas.	
RR	Western Redcedar – Black Cottonwood Riparian	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that may succeed either through deciduous seral species or directly to a climax of hybrid spruce, western redcedar, and western hemlock. Found extensively throughout valleys of the Southern Interior Mountains and portions of the Northern Thompson Upland and Northern Okanagan Highland, between approximately 400 and 1450 m elevation. It also occurs between 350 and 1100 m in the valleys of the Skeena Mountains, Nass Basin, and Nass Ranges.	*ESSFvc ESSFwc1 ESSFwc2 ICHdk ICHdw ICHmc1 ICHxw ICHmk1 ICHmk2 ICHmk3 ICHmm ICHmw1 ICHmw2 ICHmw3 ICHvk1 ICHwk1 ICHwk2 ICHwk3 ICHwk4 ICHvk2 IDFmw1 IDFmw2 IDFww*
RS	Western Redcedar Swamp	A swamp wetland class that typically is an open forested wetland composed of western redcedar and various conifers, with a skunk cabbage and fern understorey associated with very poorly drained sites. The redcedar swamp is limited in size but has an extensive distribution. It occurs between 400 and 1550 m on the more gentle slopes of the Southern Interior Mountains and portions of the Northern Thompson Upland and Northern Okanagan Highland. It occurs throughout the Coastal Douglas-fir (CDF) and Coastal Western Hemlock (CWH) biogeoclimatic zones of the Coast Mountains and Vancouver Island regions between sea level and approximately 1000 m.	*CDFmm CWHdm CWHds1 CWHds2 CWHmm1 CWHmm2 CWHms1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHwm CWHwh1 CWHwh2 CWHws1 CWHws2 CWHxm ICHmk1 ICHmk2 ICHmk3 ICHmw1 ICHmw2 ICHmw3 ICHvk1 ICHvk2 ICHwk1 ICHwk2 ICHwk3 IDFmw2 IDFww*
SA	Sub-boreal White Spruce – Trembling Aspen	Typically a dense mixed or coniferous sub-boreal forest with shrub- and herb-dominated understories, which includes plant communities that succeed through trembling aspen seral forests to a white spruce climax.	
SB	White Spruce – Paper Birch	Typically a dense, mixed sub-boreal forest with dense shrub-dominated understories, which includes plant communities that succeed through paper birch, trembling aspen, and Douglas-fir seral forests to a white spruce climax. Found on the lower valley slopes and valley bottoms between the elevations of 450 and 1225 m in the Rocky Mountain Trench, Fraser Basin, and northern Fraser Plateau.	*SBSmh*

Code	Name[1]	Description	BEC units
SC	Shrub-Carr	A shrub-carr wetland class that typically is dominated by shrubs, found on poorly drained mineral soil sites. Occurs along stream edges, drainage ways, small depressions, and the perimeters of lakes, ponds, and sedge wetlands in most areas.	
SD	Spruce – Douglas-fir	Typically a dense coniferous forest with soopolallie- or pinegrass-dominated understories, which includes plant communities that progress though a mixture of lodgepole pine, Douglas-fir, and western larch to a white spruce and subalpine fir climax; sometimes with lodgepole pine or trembling aspen present. Located between 600 and 1600 m in the areas around the Nechako, Fraser, and Thompson plateaus, as well as in the Okanagan Highland. It is also located in the southern Rocky Mountains, southern Rocky Mountain Trench, south-eastern Purcell and Monashee mountains, as well as the leeside of the Cascade Mountains.	*MSdk MSdm1 SBSdh SBSdk SBSdw1 SBSdw2 SBSdw3 SBSvk IDFdk1 IDFdk2 IDFdk3 IDFdm1 IDFdm2 IDFxh1 IDFxm IDFxw*
SF	White Spruce – Subalpine Fir	Typically a dense, coniferous sub-boreal forest with dense shrub- and moss-dominated understories, which includes communities that progress directly to a white spruce and subalpine fir climax, sometimes with lodgepole pine or trembling aspen. This unit is common throughout the lowland forests found on the Fraser Plateau, Fraser Basin, Nass Basin, Central Canadian Rocky Mountains, Omineca Mountains, Skeena Mountains, and Columbia Highlands. It also occurs to a limited extent in the Southern Rocky Mountain Trench and on the Thompson-Okanagan Plateau. In northerly areas it commonly occurs between 500 and 1200 m elevation, while more southerly locations occur at higher elevations between 1000 and 1650 m.	*ESSFmv3 SBSdh SBSdk SBSdw1 SBSdw2 SBSdw3 SBSmc1 SBSmc2 SBSmc3 SBSmh SBSmk1 SBSmk2 SBSmm SBSmw SBSvk SBSwk1 SBSwk2 SBSwk3 MSdc MSdm1 MSdm2 MSxk ICHdk ICHmk1 ICHmk3 ICHvc ICHwc ICHwk2 ICHwk4*
SG	Subalpine Grassland	Typically a high elevation, lush grassland habitat dominated by perennial grasses and forbs, on dry sites. This uncommon unit occurs on isolated, high elevation sites throughout the Northern Boreal Mountains, Omineca Mountains, Central Canadian Rockies, and Southern Interior Mountains. It is found at elevations ranging between 1000 and 1600 m in the north and approximately 1600 and 2000 m in the south.	*BWBSdk1 SWBmk ESSFdk ESSFmv ESSFxc ESSFxv*
SH	Shrub Fen	A fen wetland class that is typically dominated by shrubs, found on poorly drained organic sites. Common throughout the interior of the province, with the exception of the Bunchgrass (BG), Ponderosa Pine (PP), and Alpine Tundra (AT) zones. Limited to areas that are poorly drained, subhydric, and depressional or level.	

Code	Name[1]	Description	BEC units
SK	Spruce – Swamp	A swamp wetland class that typically is an open forested wetland of spruce with an understorey of skunk cabbage and sparse shrubs, found on very poorly drained sites. Located throughout the interior of the province, east of the Coast Mountains including the Northern Boreal Mountains; Taiga and Boreal plains; central, southern, and sub-boreal Interior; and the Southern Interior Mountains. Generally found at mid-elevations between 400 and 1400 m; more northerly locations may occur at lower elevations while more southerly areas may occur at higher elevations.	*IDFdk3 IDFdk4 SBPSdc SBPSmc SBPSmk SBPSxc BWBSdk1 SBSdw1 SBSmc2 SBSmh SBSvk ICHdk ICHmc2 ICHmk1 ICHmk2 ICHmw3 ICHwk4 ICHvc ICHwk1*
SL	Sub-boreal White Spruce – Lodgepole Pine	Typically a dense, sub-boreal coniferous forest that includes plant communities that succeed through lodgepole pine seral forests to a white spruce climax. This unit occurs extensively in the Southern Rocky Mountain Trench, Fraser Basin, Omineca Mountains, and northern portion of the Fraser Plateau; elevational limits range between 700 and 1400 m. It is also present at higher elevations between 1200 and 1650 m, and in portions of the southern Fraser and Thompson-Okanagan plateaus.	*SBSdk SBSdw1 SBSdw2 SBSdw3 SBSmc1 SBSmc2 SBSmc3 SBSmh SBSmk1 SBSmk2 SBSwk3 SBPSdc SBPSmc SBPSmk SBPSxc IDFdk3 IDFdk4 IDFdm2 MSxk MSxv*
SM	Subalpine Meadow	Typically a high elevation meadow community, dominated by moisture-loving herbaceous species, found on wetter sites in the subalpine forested areas. This unit occurs throughout the province at elevations ranging between 1000 and 1600 m in the north and 1600 and 2000 m in the south. It occurs in the Vancouver Island and Queen Charlotte Islands Ranges, Coast Mountains, Southern Interior Mountains, and Northern Boreal Mountains, as well as many of the high elevation plateaus found in the province.	*ESSFdc ESSFdk ESSFmc ESSFmk ESSFmm1 ESSFmv3 ESSFmv4 ESSFmw ESSFvc ESSFwc ESSFwk1 ESSFwk2 ESSFwm ESSFwv ESSFxc ESSFxv MHmm1 MHmm2 MHwh1 SWBdk SWBmk*
SP	Slow Perennial Stream	Typically a freshwater riverine habitat contained within a channel that has continuously slow-moving water, is bounded by banks or upland habitat, and has a low gradient; may include channels that form a connecting link between two bodies of standing water. Distributed throughout the province with a larger proportion of slow-moving streams found at lower altitudes where the gradient of the stream is reduced.	

Code	Name[1]	Description	BEC units
SR	Sitka Spruce – Black Cottonwood Riparian	Typically a dense coniferous forest with fern- or shrub-dominated understories, which may progress through plant communities with red alder, black cottonwood, or bigleaf maple to a coniferous mixture of Sitka spruce and western hemlock; found on or in association with fluvial sites. Occurs extensively throughout valley bottoms of the Coast and Mountains ecoprovince, ranging in elevation between sea level and 1000 m.	*CDFmm CWHdm CWHmm1 CWHds1 CWHds2 CWHvm1 CWHms1 CWHms2 CWHxm CWHvh1 CWHvh2 CWHwh1 CWHwm CWHws1 CWHws2 ICHvc CDFmm CWHdm CWHds1 CWHds2 CWHmm1 CWHms1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHwh1 CWHwm CWHws1 CWHws2 CWHxm ICHmc1 ICHmc2 ICHvc ICHwc*
SS	Big Sagebrush Shrub/Grassland	Typically an open to dense, dry shrubland, dominated by drought-tolerant shrubs and perennial grasses, and generally lacking trees. This unit occurs extensively throughout the lower to middle elevations of the Southern Interior and southern portion of the Fraser Plateau; including the Fraser River, Thompson and Okanagan basins, as well as the valleys around the Fraser River in the Pavillion Ranges, Nicola River, and the Similkameen River. More isolated ecosystems are also found in the Granby and Kettle River valleys of the Southern Okanagan Highland. Elevation ranges from 250 to 1300 m with a sagebrush variety change in the higher elevation subzone (MSxk: 1450 to 1650 m).	*BGxh1 BGxh2 BGxh3 BGxw1 BGxw2 ESSFxc MSxk IDFdk1 IDFdm1 IDFxh1 IDFxh2 PPxh1 PPxh2*
ST	Subtidal Marine	Typically a habitat that consists of open ocean overlying the continental shelf with salinities in excess of 18 ppt and a substrate that is continuously submerged. This unit occurs adjacent to the intertidal shores of all coastal islands and the mainland, including major inlets, fjords, bays, and the open ocean.	*CDFmm CWHdm CWHmm1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHwh1 CWHwm CWHws1 CWHxm1 CWHxm2*

Code	Name[1]	Description	BEC units
SU	Subalpine Shrub/Grassland	Typically high elevation, northern habitat, characterized by dense shrubs and bunchgrasses, both inter-mixed and occasionally dominated by scrub birch, willows, and Altai fescue. Generally limited to the high elevation areas of the Northern Boreal Mountains and portions of the Omineca and Central Canadian Rocky Mountains. Elevational limits range between 1000 and 1600 m.	*SWBmk SWBun*
SW	Shrub Swamp	A swamp wetland class that typically is a tall shrub wetland, characterized by willows, a sparse cover of spruce and sedges, usually found along stream channels and composed of a mixture of mineral and organic material. Occurs at lower to middle elevations, in a limited extent along creeks and rivers throughout the province.	
TA	Talus	Typically sparsely vegetated, rubbly or blocky colluvial areas, at the base of rock outcroppings, cliffs, or escarpments. Found throughout the province in non-alpine areas, usually on steep slopes below rock outcrops or escarpments. The weathered bedrock sheds blocks of rubble, which accumulate in draws and across the base of steep slopes and cliffs.	
TB	Trembling Aspen – Balsam Poplar	Typically an open, deciduous subalpine forest found on warm aspects, often in association with shrub/grasslands. This important habitat occurs on steep, warm aspects in the Spruce–Willow–Birch biogeoclimatic zone. This unit is limited to elevations ranging between 1050 and 1500 m. It occurs throughout the subalpine areas of the Northern Boreal Mountains; small patches are also present in the Northern Omineca and Central Canadian Rocky mountains, as well as on the Muskwa Plateau.	*SWB*
TC	Transportation Corridor	Typically a linear-shaped land area dedicated to some form of above-ground system for carrying products from one point to another, including roads and railways. Commonly occurs in low to middle elevation biogeoclimatic units throughout the southern half of the province. In more northerly locations they are not as widespread. Transportation corridors tend to be associated with communities, linking one community to another and to resource-related activities.	
TF	Tamarack Wetland	A fen wetland class that typically is an open forested wetland, dominated by tamarack, scrub birch, sedges, and moss. Found between 300 and 1100 m elevation throughout the Boreal and Taiga Plains, as well as the Liard Basin.	*BWBSdk* *BWBSmw1* *BWBSmw2*
TR	Transmission Corridor	Typically a linear-shaped land area dedicated to some form of above or below ground system for carrying products from one point to another, including transmission lines and pipeline. Commonly occurs in low to mid-elevation biogeoclimatic units throughout the southern half of the province. In more northerly locations they are not as widespread in occurrence. Transmission corridors tend to be concentrated around hydroelectric systems.	

Code	Name[1]	Description	BEC units
UR	Urban	Typically a mixture of human-influenced habitats that includes residential and urban areas, but excludes major agricultural lands. Urban development is not limited to specific regions or particular physical environments. However, most urban centres are situated at low elevations and near the coast, large rivers, or lakes.	
UV	Unvegetated	Typically non-alpine, unvegetated areas consisting of exposed soils and excluding unvegetated bedrock sites. Typically the total cover of vegetation, including trees, shrubs, herbs, and lichens, is less than 5% of the total surface area. This limited habitat occurs as a result of natural erosion, as well as human activities. Some typical sources of exposed soils include cutbanks along watercourses and roads, beaches, gravel pits, landings for sorting and loading logs, glacial moraines, mudflats in association with dried up lakes and ponds, and steep slopes where mudslides and debris torrents commonly occur.	
WB	Whitebark Pine Subalpine	Typically a subalpine habitat of open, whitebark pine forests, inter-mixed with lush bunchgrasses, other perennial grasses, and forbs, on droughty sites. Limited to south-facing slopes above the Engelmann Spruce – Subalpine Fir (ESSF) zone and below the Alpine Tundra (AT) zone, east of the leeward Coast Mountains into the Rocky Mountains. Occurs between 1650 and 2100 m elevation in more southerly areas and between 1000 and 1800 m in more northerly locations. Note, there is considerable range in the upper and lower elevational limits due to climatic variability and differing topography.	*ESSFdk ESSFdv ESSFmk ESSFxv*
WG	Hybrid White Spruce Bog Forest	A bog wetland class that is typically a sparse to open, treed organic wetland, composed of hybrid white spruce, with minor amounts of lodgepole pine and moss-dominated understorey. Occurs throughout the interior, east of the Coast Mountains; including the sub-boreal, central and southern interior of the province and into the Southern Interior Mountains. Elevational limits range between 400 and 1450 m. More northerly locations may occur at lower elevations while more southerly locations may occur at higher elevations.	*BWBS IDF MSdk MSxv SBPS SBS ICH*
WL	Wetland	Used for any wetland habitat class that cannot be recognized at small mapping scales.	
WP	Subalpine Fir – Mountain Hemlock Wet Parkland	Typically a high elevation mosaic of tree clumps and subalpine meadows or tundra, occurring above the closed forest and below the alpine. This unit occurs above the Engelmann Spruce – Subalpine Fir (ESSF) zone in the eastern Kitimat Ranges, south/central Hazelton Mountains, southeast Boundary Ranges, and northwest Skeena Mountains; elevation is approximately 1800 m. There is also a limited amount of this unit found on the leeward side of the Pacific Ranges, as well as in the western Monashee Mountains, at approximately 1675 m. Note, there is considerable range in the upper and lower elevational limits due to climatic variability and differing topography.	*ESSFmk ESSFmw ESSFvc ESSFwv*

Code	Name[1]	Description	BEC units
WR	Hybrid White Spruce – Black Cottonwood Riparian	Typically a dense deciduous, mixed or coniferous forest with shrub-dominated understories, found on, or in association with fluvial sites; includes plant communities that succeed slowly through black cottonwood to potential hybrid white spruce climax. Occurs throughout the interior, east of the Coast Mountains; including the sub-boreal, central, and southern interior and into the Southern Interior Mountains. Elevational limits range between 400 and 1450 m. More northerly locations may occur at lower elevations while more southerly locations may occur at higher elevations.	*ICHdk ICHmc1 ICHmc2 ICHwk1 IDFdk1 IDFdk2 IDFdk3 IDFdk4 IDFdm1 IDFdm2 IDFxm IDFxw IDFxh1 IDFxh2 SBPSdc SBPSmc SBPSmk SBPSxc SBSdh1 SBSdh2 SBSdk SBSdw1 SBSdw2 SBSmc1 SBSmc2 SBSmc3 SBSmh SBSmk1 SBSmk2 SBSmm SBSmw SBSvk SBSwk1 SBSwk2 SBSwk3 MSdk MSxv PPdh2 PPxh1*
YB	Yellow-cedar Bog Forest	Typically an open forest with shrubby yellow-cedar, mountain hemlock, and western hemlock; found on poorly drained sites. This unit is found on the western slopes of the Coast Mountains, north of the Fraser River through to the Alaskan border and throughout the Hecate Lowlands. It also occurs on the islands along the coast, including the Queen Charlotte Islands and Vancouver Island. It is restricted to the windward portion of southern Vancouver Island and expands to cover all of northern Vancouver Island, north of Kelsey Bay. Typically, the elevational limits of this unit range between sea level and approximately 1800 m.	*CWHmm2 CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHwh1 CWHwh2 MHmm1 MHmm2 MHwh*
YM	Yellow-cedar – Mountain Hemlock Forest	Typically an open scrubby forest with a well-developed understorey; mountain hemlock and yellow-cedar are the dominant climax species. Occurs at high elevations on the Queen Charlotte Islands and in hypermaritime areas of the coast, including major coastal islands north of Smith Inlet; typically found at elevations ranging from 500 to 1100 m.	*MHmm1 MHmm2 MHwh*
YS	Yellow-cedar Skunk Cabbage Swamp Forest	Typically an open forested wetland of yellow-cedar with an understorey of skunk cabbage and sparse shrubs found on poorly drained mineral sites. Occurs at higher elevations, ranging between 500 and 1600 m, on the Queen Charlotte Islands, Vancouver Island, and the Mainland Coast, expanding east into the Coast Mountains and north to the Alaskan border.	*MHmm1 MHmm2 MHwh*

Appendix 7. Structural stages and codes[1]

From *Standards for Terrestrial Ecosystems Mapping in British Columbia*. 1998. Ecosystems Working Group of the Terrestrial Ecosystems Task Force, Resources Inventory Committee.

Structural stage	Description
	Post-disturbance stages or environmentally induced structural development
1 Sparse/bryoid[a]	Initial stages of primary and secondary succession; bryophytes and lichens often dominant, can be up to 100%; time since disturbance <20 years for normal forest succession, may be prolonged (50–100+ years) where there is little or no soil development (bedrock, boulder fields); total shrub and herb cover <20%; total tree layer cover <10%.
Substages	
1a Sparse[a]	<10% vegetation cover
1b Bryoid[a]	Bryophyte- and lichen-dominated communities (>½ of total vegetation cover).
	Stand initiation stages or environmentally induced structural development
2 Herb[a]	Early successional stage or herbaceous communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, **flooding**, intensive grazing, intense fire damage); dominated by herbs (forbs, graminoids, ferns); some invading or residual shrubs and trees may be present; tree layer cover <10%, shrub layer cover <or equal to 20% or <1/3 of total cover, herb-layer cover >20%, or >or equal to 1/3 of total cover; time since disturbance <20 years for normal forest succession; many herbaceous communities are perpetually maintained in this stage.
Substages	
2a Forb -dominated[a]	Herbaceous communities dominated (>½ of the total herb cover) by non-graminoid herbs, including ferns.
2b Graminoid -dominated[a]	Herbaceous communities dominated (>½ of the total herb cover) by grasses, sedges, reeds, and rushes.
2c Aquatic[a]	Herbaceous communities dominated (>½ of the total herb cover) by floating or submerged aquatic plants; does not include sedges growing in marshes with standing water (which are classed as 2b).
2d Dwarf shrub[a]	Communities dominated (>½ of the total herb cover) by dwarf woody species such as *Phyllodoce empetriformis, Cassiope mertensiana, Cassiope tetragona, Arctostaphylos arctica, Salix reticulata,* and *Rhododendron lapponicum*. (See list of dwarf shrubs assigned to the herb layer in the *Field Manual for Describing Terrestrial Ecosystems.)*
3 Shrub/Herb[b]	Early successional stage or shrub communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, **flooding**, intensive grazing, intense fire damage); dominated by shrubby vegetation; seedlings and advance regeneration may be abundant; tree layer cover <10%, shrub layer cover >20% or >or equal to 1/3 of total cover.
Substages	
3a Low shrub[b]	Communities dominated by shrub layer vegetation <2 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance <20 years for normal forest succession.

1 In the assessment of structural stage, structural features and age criteria should be considered together. Broadleaf stands will generally be younger than coniferous stands belonging to the same structural stage.

Structural stage	Description
3b Tall shrub[b]	Communities dominated by shrub layer vegetation that are 2–10 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 40 years for normal forest succession.
	Stem exclusion stages
4 Pole/Sapling[c]	Trees >10 m tall, typically densely stocked, have overtopped shrub and herb layers; younger stands are vigorous (usually >10–15 years old); older stagnated stands (up to 100 years old) are also included; self-thinning and vertical structure not yet evident in the canopy – this often occurs by age 30 in vigorous broadleaf stands, which are generally younger than coniferous stands at the same structural stage; time since disturbance is usually <40 years for normal forest succession; up to 100+ years for dense (5000–15 000+ stems per hectare) stagnant stands.
5 Young Forest[c]	Self-thinning has become evident and the forest canopy has begun differentiation into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole/sapling stage; time since disturbance is generally 40–80 years but may begin as early as age 30, depending on tree species and ecological conditions.
	Understorey reinitiation stage
6 Mature Forest[c]	Trees established after the last disturbance have matured; a second cycle of shade tolerant trees may have become established; understories become well developed as the canopy opens up; time since disturbance is generally 80–140 years for biogeoclimatic group A[d] and 80–250 years for group B.[e]
	Old-growth stage
7 Old Forest[c]	Old, structurally complex stands composed mainly of shade-tolerant and regenerating tree species, although older seral and long-lived trees from a disturbance such as fire may still dominate the upper canopy; snags and **coarse woody debris** in all stages of decomposition typical, as are patchy understories; understories may include tree species uncommon in the canopy, due to inherent limitations of these species under the given conditions; time since disturbance generally >140 years for biogeoclimatic group A[d] and >250 years for group B.[e]

a Substages 1a, 1b, and 2a–d should be used if photo interpretation is possible, otherwise, stages 1 and 2 should be used.

b Substages 3a and 3b may, for example, include very old krummholz less than 2 m tall and very old, low productivity stands (e.g., bog woodlands) <10 m tall, respectively. Stage 3, without additional substages, should be used for regenerating forest communities that are herb- or shrub-dominated, including shrub layers consisting of only 10–20% tree species, and undergoing normal succession toward climax forest (e.g., recent cut-over areas or burned areas).

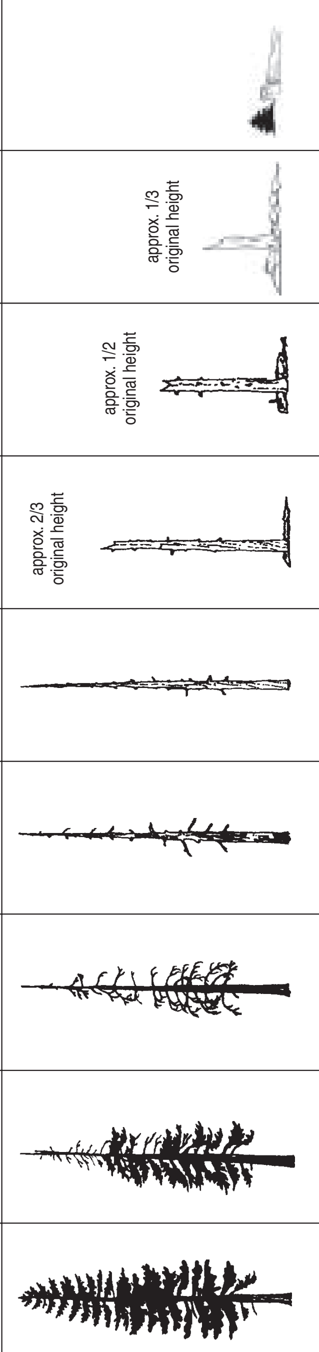
c Structural stages 4–7 will typically be estimated from a combination of attributes based on forest inventory maps and aerial photography. In addition to structural stage designation, actual age for forested units can be estimated and included as an attribute in the database, if required.

d Biogeoclimatic Group A includes BWBSdk, BWBSmw, BWBSwk, BWBSvk, ESSFdc, ESSFdk, ESSFdv, ESSFxc, ICHdk, ICHdw, ICHmk1, ICHmk2, ICHmw3, MS (all subzones), SBPS (all subzones), SBSdh, SBSdk, SBSdw, SBSmc, SBSmh, SBSmk, SBSmm, SBSmw, SBSwk1 (on plateau), and SBSwk3.

e Biogeoclimatic Group B includes all other biogeoclimatic units (see Appendix C).

Appendix 8. Wildlife tree classification for coniferous trees

From: *Vegetation Resource Inventory Ground Sampling Procedures*. 2002. B.C. Ministry of Sustainable Resource Management, Terrestrial Information Branch for the Resource Inventory Committee. See http://srmwww.gov.bc.ca/tib/veginv/publications.htm.



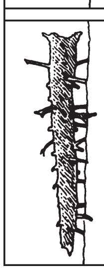
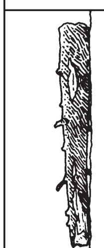
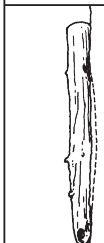
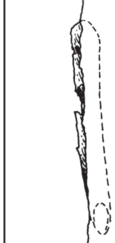
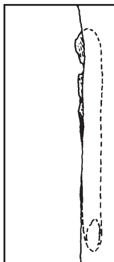
	LIVE		DEAD					DEAD FALLEN	
			Hard			Spongy	Soft		
Tree class	1	2	3	4	5	6	7	8	9
Description	**Live/healthy;** no decay; tree has valuable habitat characteristics such as large, clustered or gnarled branches, or horizontal, thickly moss-covered branches.*	**Live/unhealthy;** internal decay or growth deformities (including insect damage, broken tops); dying tree.*	**Dead;** needles or twigs may be present; roots sound.	**Dead;** no needles/twigs; 50% of branches lost; loose bark; top usually broken; roots stable.	**Dead;** most branches/bark absent; some internal decay; roots of larger trees stable.	**Dead;** no branches or bark; sapwood/heartwood sloughing from upper bole; decay more advanced; lateral roots of larger trees softening; smaller ones unstable.	**Dead;** extensive internal decay; outer shell may be hard; lateral roots completely decomposed; hollow or nearly hollow shells.		**Debris;** downed trees or stumps.
Uses and users	Nesting (e.g., Bald Eagle, Great Blue Heron colonies, Marbled Murrelet); feeding; roosting; perching.	Nesting/roosting[1]—strong PCEs[2] (woodpeckers); SCUs[3]; large-limb and platform nests (Ospreys); insect feeders.	Nesting/roosting—strong PCEs; SCUs; bats.	Nesting/roosting—PCEs; SCUs; insect feeders.	Nesting/roosting—weak PCEs (nuthatches, chickadees); SCUs; bats; insect feeders.	Weaker PCEs; SCUs; insect feeders; salamanders; small mammals; hunting perches.	Insect feeders; salamanders; small mammals; hunting perches; occasionally used by weak cavity excavators such as chickadees.		Insect feeders; salamanders; small mammals; drumming logs for grouse; flicker foraging; nutrient source.

1 Large witches' brooms provide nesting/denning habitat for some species (e.g., fisher, squirrels).
2 PCE = primary cavity excavator
3 SCU = secondary cavity user
* This classification system does not recognize root disease trees specifically. Such trees become unstable at or before death.

Appendix 9. Coarse woody debris classification

Adapted from: *Vegetation Resource Inventory Ground Sampling Procedures*. 2002. B.C. Ministry of Sustainable Resource Management, Terrestrial Information Branch for the Resource Inventory Committee. See http://srmwww.gov.bc.ca/risc/pubs/teveg/vri%20ground%20sampling2k2/vrigro%7e1.pdf.

Decay Class

Characteristics of fallen	 **Log class 1**	 **Log class 2**	 **Log class 3**	 **Log class 4**	 **Log class 5**
Bark	intact	intact	trace	absent	absent
Twigs	present	absent	absent	absent	absent
Texture	intact	intact to partly soft	hard, large pieces	small, soft blocky pieces	soft and powdery
Shape	round	round	round	round to oval	oval
Colour of wood	original colour	original colour	original colour to faded	light brown to reddish brown	red brown to dark brown
Portion of tree on ground	tree elevated on support points	tree elevated on support points but sagging slightly	tree sagging near ground	all of tree on ground	all of tree on ground
Invading roots	none	none	in sapwood	in heartwood	in heartwood

Appendix 10. Scientific names of commonly referred to tree and wildlife species

English name	Scientific name	Code
Alaska paper birch	*Betula neoalaskana*	Ea
alpine larch	*Larix lyallii*	La
amabilis fir	*Abies amabilis*	Ba
balsam poplar	*Populus balsamifera* ssp. *balsamifera*	Acb
bigleaf maple	*Acer macrophyllum*	Mb
black cottonwood	*Populus balsamifera* ssp. *trichocarpa*	Act
Douglas-fir	*Pseudotsuga menziesii*	Fd
Engelmann spruce	*Picea engelmannii*	Se
Garry oak	*Quercus garryana*	Qg
grand fir	*Abies grandis*	Bg
jack pine	*Pinus banksiana*	Pj
limber pine	*Pinus flexilis*	Pf
lodgepole pine	*Pinus contorta*	Pl
mountain hemlock	*Tsuga mertensiana*	Hm
Pacific dogwood	*Cornus nuttallii*	Gp
paper birch	*Betula papyrifera*	Ep
ponderosa pine	*Pinus ponderosa*	Py
poplar	*Populus balsamifera*	Ac
red alder	*Alnus rubra*	Dr
Sitka spruce	*Picea sitchensis*	Ss
subalpine fir	*Abies lasiocarpa*	Bl
tamarack	*Larix laricina*	Lt
trembling aspen	*Populus tremuloides*	At
vine maple	*Acer circinatum*	Mv
water birch	*Betula occidentalis*	Ew
western hemlock	*Tsuga heterophylla*	Hw
western larch	*Larix occidentalis*	Lw
western redcedar	*Thuja plicata*	Cw
western white pine	*Pinus monticola*	Pw
white spruce	*Picea glauca*	Sw
whitebark pine	*Pinus albicaulis*	Pa
yellow-cedar	*Chamaecyparis nootkatensis*	Yc
Pileated Woodpecker	*Dryocopus pileatus*	B-PIWO
Northern Flicker	*Colaptes auratus*	B-NOFL
Hairy Woodpecker	*Picoides villosus*	B-HAWO
Red-breasted Sapsucker	*Sphyrapicus rubber*	B-RBSA

Appendix 11. NatureServe status

NatureServe is a non-profit and independent organization that provides information on the conservation status of the world's plants, animals, and ecological communities. Formed in 1999 by the Nature Conservancy and the Natural Heritage Network, NatureServe uses standard criteria developed by NatureServe, the Nature Conservancy, and the Natural Heritage Network to assign conservation ranks. The ranking system is unique in three key respects: it is based on objective biological criteria; it is applicable at multiple geographic levels; and it includes ranks not just for species but for ecological communities. For more information on NatureServe, its methods, and its ranks, visit the NatureServe Web page at http://www.natureserve.org/explorer/aboutd.htm.

In short, each element is ranked at three geographic levels: global (G), national (N), and subnational (S). The global rank is based on the status of the element throughout its entire range whereas the subnational rank is based solely on its status within a state, province, or territory. Each element is assigned a rank between one and five unless considered extirpated, extinct, historical, or unranked (see descriptions below). The rank is based on the number of extant occurrences of the element, but other factors such as abundance, range, protection, and threats are also considered if the information is available. For information on ranking in British Columbia, visit http://wlapwww.gov.bc.ca/wld/documents/ranking.pdf.

Code	Rank	Definition
1	Critically Imperiled	*Extremely rare or some factor(s) makes it especially susceptible to extirpation or extinction. Typically ≤5 existing occurrences or very few remaining individuals.*
2	Imperiled	*Rare or some factor(s) makes it very susceptible to extirpation or extinction. Typically 6 to 20 existing occurrences or few remaining individuals.*
3	Vulnerable	*Rare and local, found only in a restricted range (even if abundant at some locations), or because of some other factor(s) making it susceptible to extirpation or extinction. Typically 21 to 100 existing occurrences.*
4	Apparently Secure	*Uncommon but not rare, and usually widespread in the province. Possible cause for long-term concern. Typically >100 existing occurrences.*
5	Secure	*Common to very common, typically widespread and abundant, and not susceptible to extirpation or extinction under present conditions.*
X	Extirpated or extinct	*Not located despite intensive searches and no expectation that it will be rediscovered; presumed to be extirpated or extinct.*
H	Historical	*Not located in the last 50 years, but some expectation that it may be rediscovered.*
?	Unranked	*Rank not yet assessed.*
U	Unrankable	*Due to current lack of available information.*

In addition to the above ranks, the following ranking modifiers are defined below.

B	Associated rank refers to breeding occurrences of mobile animals
E	An exotic species or species introduced by humans to the province
N	Associated rank refers to non-breeding occurrences of mobile animals
Q	Taxonomic status is unclear or is in question
R	Reported from the province, but without persuasive documentation for either accepting or rejecting the report
T	A rank associated with a subspecies or variety
Z	Occurs in the province but as a diffuse, usually moving population; difficult or impossible to map static occurrences

Appendix 12. Determining wildlife tree dbh recommendations for cavity-nesters

Resource managers often apply minimum size recommendations (e.g., wildlife tree dbh) to achieve wildlife conservation objectives. The use of minimum dbh sizes for retention of wildlife trees may not be the best management practice for cavity-nesters. Larger diameter wildlife trees provide important features including larger diameter cavities and thicker insulation around the nest cavity. An alternative approach to minimum sizes is to use the mean plus one standard deviation. Since information is not always available for a specific species of cavity-nester, it may be possible to use information from a primary cavity-nester to approximate the characteristics of the trees that will be selected by the secondary cavity-nester. Both the Pileated Woodpecker (*Dryocopus pileatus*) and Northern Flicker (*Colaptes auratus*) are primary cavity nesters and provide nesting and roosting cavities for many secondary cavity users. A summary of the nesting requirements of these two species is provided in Tables 12-1 and 12-2.

Table 12-1. Characteristics (mean ± SD) (cm) of Pileated Woodpecker nest trees in coastal and interior ecosystems

Location	Forest type	N	Tree dbh (cm)	Tree height (m)	Nest height (m)	Citation
Coastal ecosystems						
Western Washington	Western hemlock, Pacific silver fir	27	100.5	39.7	35.2	Aubrey and Raley (1996)
Oregon Coast Ranges	Western hemlock	15	68.9 ± 25	26.5 ± 16	19.9 ± 11	Mellen (1987)
Oregon Coast Ranges	Western hemlock	6	67.0 ± 20.3	26.5 ± 14.7	16.7 ± 5.4	Nelson (1988)
South Cascades	Mixed conifer to Douglas-fir	2	88.0 ± 19.8	40.0 ± 4.2	19.0 ± 4.2	Lundquist (1988)
Southeast Vancouver Island	CWHxm, CDF	7	82 ± 42	22 ± 13.8	17.4 ± 9.3	Hartwig (1999)
North Vancouver Island	CWHxm, CWHvm, MHmm	2	84.2 ± 17.5	36.7 ± 9.1	16.1 ± 3.4	Deal and Setterington (2000)
Interior ecosystems						
Blue Mountains, Oregon	Coniferous	105	84	28	15	Bull (1987)
Okanogan National Forest	Coniferous	6	84.2 ± 17.5	36.7 ± 9.1	16.1 ± 3.4	Madsen (1985)
Northern Montana	Coniferous	89	73.4 ± 1.9	29.0 ± 1.0	15.9 ± 0.6	McClelland and McClelland (1999)
South-central B.C.	Deciduous (IDF)	20	40.5 ± 7.1	19.2 ± 6.3	9.2 ± 1.8	Harestad and Keisker (1989)
West-central Alberta and northern B.C.	Deciduous	98	44.0			Bonar (1997)

Table 12-2. Characteristics (mean ± SD) of Northern Flicker nest trees in coastal and interior ecosystems

Location	Forest type	N	Tree dbh (cm)	Tree height (m)	Nest height (m)	Citation
Coastal ecosystems						
Northern Vancouver Island	CWHxm, CWHvm, MHmm	85	73.1 ± 3.4	22.6 ± 1.1		Deal and Setterington (2000)
Oregon Coast Ranges	Western hemlock	9	95.8 ± 30.0	38.6 ± 9.6	35.6 ± 10.8	Nelson (1988)
South Cascades	Mixed conifer to Douglas-fir	3	127.7 ± 38.5	46.3 ± 15.0	38.7 ± 20.6	Lundquist (1988)
Interior ecosystems						
Okanogan National Forest	Coniferous	16	70.4 ± 27.2	20.8 ± 11.9	14.3 ± 9.7	Madsen (1985)
South-central B.C.	Deciduous	17	31.9 ± 9.9	14.7 ± 7.8	5.7 ± 3.7	Harestad and Keisker (1989)
Riske Creek, B.C.	Deciduous	159	33.87 ± 10.34		3.32 ± 2.82	Wiebe (2001)

Many secondary cavity-nesters depend on more than one primary cavity-excavator for suitable cavities. Thus several data sets can be combined by using a weighted mean, which will give proportional weight to studies according to their sample sizes. This method may be used to calculate an optimum recommended dbh tree size for retention in coastal and interior ecosystems (see Table 12-3 for examples or the Pileated Woodpecker and Northern Flicker).

1. Derive recommended mean from mean values from studies on appropriate species of cavity-nesters.
2. Standardize data from studies by converting standard errors to standard deviation. Standard deviation = standard error * √n (Zar 1996).
3. Include data from generally similar ecosystems (i.e., northwestern U.S. and southwestern Canada and separate interior from coastal studies when appropriate).
4. Give more weight to studies that have larger sample sizes by using a weighted mean. The recommended mean is a weighted mean that is being used here to combine the means from two or more studies while adjusting for differences between subgroup frequencies (weighted mean = $\sum x_i * n_i / \sum n_i$). A pooled standard deviation can be calculated from the studies. Pooled SD = $\sqrt{[\sum [SD_i^2 (n_i - 1)] / [\sum n_i - G]}$ where G is the number of groups or studies (R. Davidson, statistics professor, Univ. Victoria, BC, retired).

Table 12-3. Recommendations for optimum size dbh (mean + 1SD) (cm) for Northern Flicker and Pileated Woodpecker in British Columbia based on weighted mean and pooled standard deviation

	Northern Flicker		Pileated Woodpecker	
Location	**Coniferous**	**Deciduous**	**Coniferous**	**Deciduous**
Interior ecosystems	70–98[a] or larger	34–44 or larger	74–80 or larger	41–48 or larger
Coastal ecosystems	77–88 or larger		74–102 or larger	

a After Madsen (1985) only.

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Appendix 13. Southern Interior region Identified Wildlife forest district tables

100 Mile House Forest District

Common Name	CAB	CAP	FRB	PAR	QUH	SHH	TRU
Amphibians							
Great Basin Spadefoot	X	P	P	P			
Reptiles							
Great Basin Gopher Snake			X	X			
Racer			X	X			
Birds							
American White Pelican	X		X				
Columbian Sharp-tailed Grouse	X		X	X			X
Flammulated Owl	X		X	X			X
Great Blue Heron	X	X	X	X		X	X
Lewis's Woodpecker	P	P	X	X			X
Long-billed Curlew	X		X	X			
Prairie Falcon	X	X	X				
Sagebrush Brewer's Sparrow			P				
Sandhill Crane	X	X	X		X	X	X
Short-eared Owl	X		X				
Yellow-breasted Chat			P				
Mammals							
Badger	X	X	X	X		X	
Bighorn Sheep	X		X	X			
Fisher	X	X	X	X	X	X	X
Fringed Myotis	P		X	P			
Grizzly Bear	H	*	H	*	X	X	X
Mountain Caribou					X	X	
Spotted Bat	X		X	X			
Wolverine	X	X	X	X	X	X	X
Plant communities							
Alkali Saltgrass herbaceous vegetation	X		X	X			
Douglas-fir/Common Juniper/Cladonia		X	X	X			

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Arrow Boundary Forest District

Common Name	CCM	NKM	NOH	SCM	SFH	SOH
Fish						
Bull Trout	X	X	X	X	X	
Westslope Cutthroat Trout	T	T		T	T	
Amphibians						
Coeur d'Alene Salamander	X			X	X	
Great Basin Spadefoot			X		P	X
Tiger Salamander			X		P	X
Reptiles						
Great Basin Gopher Snake			X			X
Racer			X		X	X
Western Rattlesnake			X		X	X
Birds						
American White Pelican					X	
Columbian Sharp-tailed Grouse			X			X
Great Blue Heron	X		X	X	X	X
Interior Western Screech-Owl			X	X	X	X
Lewis's Woodpecker	X		X	X	X	X
Long-billed Curlew			X	X		X
Prairie Falcon				X		X
Sandhill Crane				X	X	
Short-eared Owl			X	X	X	X
White-headed Woodpecker			X	X	X	X
Williamson's Sapsucker	X		X	X	X	X
Mammals						
Badger			X	X	X	X
Bighorn Sheep			X	X	X	X
Fisher	X	X	X		X	X
Fringed Myotis			X		P	X
Grizzly Bear	X	X	*	X	X	
Mountain Caribou	X	X		X		
Wolverine	X	X	X	X	X	X
Plant communities						
Ponderosa Pine/Bluebunch Wheatgrass – Silky Lupine						X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Cascades Forest District

Common Name	CCR	CPR	EPR	FRB	GUU	HOR	LPR	NIB	OKR	PAR	SCR	STU	THB
Invertebrates													
Sonora Skipper			X						X			X	
Fish													
Bull Trout	X	X	X	X	X	X	X	X		X	X	X	X
Amphibians													
Coastal Tailed Frog		X	X			X	X		X	X	X	X	
Great Basin Spadefoot				P					X	P		X	X
Reptiles													
Great Basin Gopher Snake				X					X	X		X	X
Racer				X	X		X	X	X	X	X	X	X
Western Rattlesnake					X			X	X	X		X	X
Birds													
Burrowing Owl				I				X	X			X	X
Columbian Sharp-tailed Grouse	X			X	X			X	X	X		X	X
Flammulated Owl	X			X	X			X	X	X	X	X	X
Great Blue Heron		X	X	X	X		X	X	X	X	X	X	X
Interior Western Screech-Owl					X			X	X			I	I
Lewis's Woodpecker	P			X	X			X	X	X	X	X	X
Long-billed Curlew				X	X			X	X	X		X	X
Prairie Falcon				X	X			X	X			X	X
Spotted Owl			X			X	X						
Sandhill Crane		X		X	X			X	X			X	X
White-headed Woodpecker									X			I	I
Williamson's Sapsucker					X			X	X	X		X	X
Yellow-breasted Chat				P					X				P
Mammals													
Badger				X		X			X	X		X	X
Bighorn Sheep	X			X					X	X	X	X	X
Fisher	X	X		X	X	X	X	X	X	X	X		
Fringed Myotis				X	X			X	X	P		X	X
Grizzly Bear	X	X	*	H	X	X	X	X	*	*	X	*	H
Spotted Bat				X					X	X	X	X	X
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X	X
Plant communities													
Alkali Saltgrass herbaceous vegetation				X	X			X		X			X
Douglas-fir/Common Juniper/ Cladonia				X						X			
Vasey's Big Sage/Pinegrass									X			X	
Western Hemlock – Douglas-fir/Electrified Cat's-tail			X				X						
Western Redcedar – Douglas-fir/Devil's-club		X	X				X						
Western Redcedar – Douglas-fir/ Vine Maple	X		X				X						

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Central Cariboo Forest District

Common Name	BOV	CAB	CAM	CAP	CCR	CHP	FRB	NAU	QUH	QUL	SCR
Fish											
Bull Trout	X	X	X	X	X	X	X	X	X	X	X
Amphibians											
Great Basin Spadefoot		X		P		P	P				
Reptiles											
Great Basin Gopher Snake					P		X				
Racer					P		X				X
Birds											
American White Pelican		X				X	X	X		X	
Columbian Sharp-tailed Grouse		X		X	X	X	X	X		X	
Flammulated Owl		X			X	X	X			X	X
Great Blue Heron		X	X	X		X	X	X			X
Lewis's Woodpecker		P		P	P	P	X			P	X
Long-billed Curlew		X		X		X	X			X	
Prairie Falcon		X		X		X	X				
Sagebrush Brewer's Sparrow							P				
Sandhill Crane			X	X		X	X	X	X	X	
Short-eared Owl		X			X	X	X			X	
Yellow-breasted Chat							P				
Mammals											
Badger		X		X		X	X				
Bighorn Sheep		X			X	X	X				X
Fisher	X	X	X	X	X	X	X	X	X	X	X
Fringed Myotis		P				?	X				
Grizzly Bear	X	H	X	*	X	*	H	*	X	*	X
Mountain Caribou	X		X						X		
Spotted Bat		X				X	X				X
Wolverine	X	X	X	X	X	X	X	X	X	X	X
Plant communities											
Alkali Saltgrass herbaceous vegetation						X	X				
Douglas-fir/Common Juniper/Cladonia				X		X	X			X	
Hybrid White Spruce/Ostrich Fern				X						X	

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Chilcotin Forest District

Common Name	CCR	CHP	CPR	FRB	NAU	SCR	WCR	WCU
Fish								
Bull Trout	X	X	X	X	X	X	X	X
Birds								
American White Pelican		X		X	X			X
Columbian Sharp-tailed Grouse	X	X		X	X			
Flammulated Owl	X	X		X		X		
Great Blue Heron		X	X	X	X	X		
Lewis's Woodpecker		X		P				
Long-billed Curlew		X		X				
Prairie Falcon		X		X				
Sandhill Crane		X	X	X	X		X	X
Short-eared Owl	X	X		X				
Mammals								
Badger		X		X				
Bighorn Sheep	X	X		X		X		X
Fisher	X	X	X	X	X	X	X	X
Fringed Myotis		P		X				
Grizzly Bear	X	*	X	H	*	X	X	X
Northern Caribou		X			X		X	X
Spotted Bat				X				
Wolverine	X	X	X	X	X	X	X	X
Plant communities								
Alkali Saltgrass herbaceous vegetation		X		X				
Douglas-fir/Common Juniper/ Cladonia		X		X				
Western Hemlock – Douglas-fir/ Electrified Cat's-tail Moss			X				X	
Western Redcedar – Douglas-fir/ Devil's-club			X				X	
Western Redcedar – Douglas-fir/ Vine Maple	X						X	

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Columbia Forest District

Common Name	BBT	CCM	CPK	EPM	NKM	SPK	UCV
Fish							
Bull Trout	X	X	X	X	X	X	X
Westslope Cutthroat Trout	X	X	X	X	X	X	X
Amphibians							
Coeur d'Alene Salamander		X					
Northern Leopard Frog							H
Birds							
Great Blue Heron	X	X		X		X	X
Lewis's Woodpecker		P		P		P	P
Short-eared Owl	P		P		P		
Mammals							
Badger				X		X	
Bighorn Sheep			X			X	
Fisher	X	X		X	X	P	X
Grizzly Bear	X	X	X	X	X	X	X
Mountain Caribou	X	X	X	X	X		
Wolverine	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Headwaters Forest District

Common Name	BBT	CAM	CAP	CPK	NKM	NPK	NTU	QUH	SHH	SHR	UFT
Fish											
Bull Trout	X	X	X	X	X	X	X	X	X	X	X
Birds											
Great Blue Heron	X	X	X			X	X		X		X
Lewis's Woodpecker			P				X				
Long-billed Curlew							X				X
Sandhill Crane	X						X				
Mammals											
Badger			X				X				
Bighorn Sheep				X		X	X			X	
Fisher	X	X	X		X	X	X	X	X	X	X
Grizzly Bear	X	X	*	X	X	X	*	X	X	X	X
Mountain Caribou	X	X		X	X	X		X	X		X
Wolverine	X	X	X	X	X	X	X	X	X	X	X

Kamloops Forest District

Common Name	CAB	CAP	GUU	NIB	NTU	PAR	SHB	SHH	STU	THB	TRU
Fish											
Bull Trout	X	X	X	X	X	X	X	X	X	X	X
Amphibians											
Great Basin Spadefoot	X	X			X	P	X		X	X	
Reptiles											
Great Basin Gopher Snake						X	X		X	X	
Racer			X	X		X	X		X	X	
Western Rattlesnake			X	X	X	X			X	X	

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Kamloops Forest District (continued)

Common Name	CAB	CAP	GUU	NIB	NTU	PAR	SHB	SHH	STU	THB	TRU
Birds											
American White Pelican	X								X	X	
Burrowing Owl				X					X	X	
Columbian Sharp-tailed Grouse	X		X	X	X	X	X		X	X	X
Flammulated Owl	X		X	X	X	X	X		X	X	X
Grasshopper Sparrow			X	X					X	X	
Great Blue Heron	X	X	X	X	X	X	X	X	X	X	X
Interior Western Screech-Owl			X	X	X				I	I	I
Lewis's Woodpecker	P	P	X	X	X	X	X		X	X	X
Long-billed Curlew	X		X	X	X	X	X		X	X	
Prairie Falcon	X	X	X	X			X		X	X	
Sage Thrasher						X				X	
Sagebrush Brewer's Sparrow					P					P	
Short-eared Owl	X		X	X			X		X	X	
Williamson's Sapsucker			X	X		X	X		X	X	
Yellow-breasted Chat										P	
Mammals											
Badger	X	X			X	X		X	X	X	
Bighorn Sheep	X				X	X			X	X	
Fisher	X	X	X	X	X	X	X	X			X
Fringed Myotis	P		X	X		P	X		X	X	
Grizzly Bear	H	*	X	X	*	*	X	X	*	H	X
Spotted Bat	X					X			X	X	
Wolverine	X	X	X	X	X	X	X	X	X	X	X
Plant communities											
Alkali Saltgrass herbaceous vegetation	X		X	X		X				X	
Vasey's Big Sagebrush/ Pinegrass									X		

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Kootenay Lake Forest District

Common Name	CCM	EPM	MCR	NKM	SCM	SPM
Fish						
Bull Trout	X	X	X	X	X	X
Westslope Cutthroat Trout	I	X	X	X	X	X
Amphibians						
Coeur d'Alene Salamander	X		X		X	X
Northern Leopard Frog					X	
Birds						
Great Blue Heron	X	X	X		X	X
Interior Western Screech-Owl					X	X
Lewis's Woodpecker	X	X	X		X	X
Long-billed Curlew					X	
Prairie Falcon			X		X	
Sandhill Crane					X	
Short-eared Owl					X	X
White-headed Woodpecker					I	
Yellow-breasted Chat					P	
Mammals						
Badger		X	X		X	
Bighorn Sheep					X	
Fisher	X	X	X	X		X
Grizzly Bear	X	X	X	X	X	X
Mountain Caribou	X	X		X	X	
Wolverine	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Okanagan Shuswap Forest District

Common Name	CCM	HOR	NKM	NOB	NOH	OKR	SFH	SHB	SHH	SOB	SOH	STU	THB
Invertebrates													
Sonora Skipper						X						X	
Sooty Hairstreak						X				X	X		
Fish													
Bull Trout	X	X	X				X	X	X			X	X
Westslope Cutthroat Trout	T		T			T	T						
Amphibians													
Coastal Tailed Frog		X				X						X	
Great Basin Spadefoot				X	X	X	P	X		X	X	X	X
Northern Leopard Frog				H		H				H			
Tiger Salamander				X	X	X	P			X	X	X	
Reptiles													
Great Basin Gopher Snake				X	X	X		X		X	X	X	X
Racer				X	X	X	X	X		X	X	X	X
Western Rattlesnake				X	X	X	X			X	X	X	X
Birds													
American White Pelican				X			X			X		X	X
Burrowing Owl				X	X	X				X	X	X	X
Columbian Sharp-tailed Grouse				X	X	X		X		X	X	X	X
Flammulated Owl				X	X	X		X		X	X	X	X
Grasshopper Sparrow				X		X				X		X	X
Great Blue Heron	X			X	X	X	X	X	X	X	X	X	X
Interior Western Screech-Owl				X	X	X		X		X	X	I	I
Lewis's Woodpecker	X			X	X	X	X	X		X	X	X	X
Long-billed Curlew				X	X	X		X		X	X	X	X
Prairie Falcon				X		X		X		X	X	X	X
Sage Thrasher				X		X				X			X
Sagebrush Brewer's Sparrow				X		X				X			P
Sandhill Crane				X		X	X	X	X	X		X	X
Short-eared Owl				X	X	X	X	X		X	X	X	X
White-headed Woodpecker				X	X	X	X			X	X	I	I
Williamson's Sapsucker	X			X	X	X	X	X		X	X	X	X
Yellow-breasted Chat				X		X				X	X		P

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Okanagan Shuswap Forest District (continued)

Common Name	CCM	HOR	NKM	NOB	NOH	OKR	SFH	SHB	SHH	SOB	SOH	STU	THB
Mammals													
Badger		X		X	X	X	X		X	X	X	X	X
Bighorn Sheep				X	X	X	X			X	X	X	X
Fisher	X	X	X		X	X	X	X	X		X		
Fringed Myotis				X	X	X	P	X		X	X	X	X
Grizzly Bear	X	X	X	H	*	*	X	X	X	H	H	*	H
Spotted Bat				X	P	X				X		X	X
Mountain Caribou	X		X						X				
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X	X
Plant communities													
Alkali Saltgrass herbaceous vegetation				X						X			X
Antelope-Brush/ Needle-and-Thread Grass				X						X			
Vasey's Big Sage/Pinegrass						X						X	
Water Birch – Red-osier Dogwood				X						X			

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Quesnel Forest District

Common Name	BOV	CAB	CAM	CAP	NAU	QUH	QUL	WCU
Fish								
Bull Trout	X	X	X	X	X	X	X	X
Birds								
American White Pelican		X			X		X	X
Columbian Sharp-tailed Grouse		X		P	X		X	
Great Blue Heron		X		X	X		X	
Long-billed Curlew		X					X	
Sandhill Crane		X	X	X	X	X	X	X
Short-eared Owl		X					X	
Mammals								
Badger		X		X				
Fisher	X	X	X	X	X	X	X	X
Grizzly Bear	X	H	X	*	*	X	*	X
Mountain Caribou	X		X			X		
Northern Caribou					X			X
Wolverine	X	X	X	X	X	X	X	X
Plant communities								
Alkali Saltgrass herbaceous vegetation		P						
Douglas-fir/Common Juniper/Cladonia				X			X	
Hybrid White Spruce/Ostrich Fern				X			X	

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Rocky Mountain Forest District

Common Name	CCM	COC	EKT	ELV	EPM	FLV	MCR	NKM	SPK	SPM	UCV
Invertebrates											
Gillett's Checkerspot		X		X		X					
Fish											
Bull Trout	X	X	X	X	X	X	X	X	X	X	X
Westslope Cutthroat Trout	X	X	X	X	X	X	X	X	X	X	X
Amphibians											
Coeur d'Alene Salamander	X						X			X	
Northern Leopard Frog			H			H					H
Rocky Mountain Tailed Frog						X	X			X	
Birds											
Burrowing Owl			I								
Columbia Sharp-tailed Grouse			X								X
Flammulated Owl			X		X		X				X
Great Blue Heron	X		X		X		X		X	X	X
Lewis's Woodpecker	X		X	X	X		X		X	X	X
Long-billed Curlew			X	X							X
Prairie Falcon			X				X				
Sandhill Crane			X							X	X
Short-eared Owl			X							X	
Williamson's Sapsucker	X	X	X		X	X	X		X	X	
Mammals											
Badger		X	X		X	X	X		X		
Bighorn Sheep		X	X						X		
Fisher	X	P	P	X	X	P	X	X	P	X	X
Grizzly Bear	X	X	X	X	X	X	X	X	X	X	X
Mountain Caribou	X				X			X			
Wolverine	X	X	X	X	X	X	X	X	X	X	X
Plant communities											
Alkali Saltgrass herbaceous vegetation			X								
Antelope-Brush/ Bluebunch Wheatgrass			X								
Douglas-fir/Snowberry/ Balsamroot			X								
Ponderosa Pine/ Bluebunch Wheatgrass – Silky Lupine			X								

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts